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AN INVESTIGATION INTO THE
ACCURACY OF METROGON PHOTOGRAPHY.

CHARLES FREDERICK WILLETT

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AN INVESTIGATION INTO THE ACCURACY
OF METROGON PHOTOGRAPHY

A Thesis

Presented in Partial Fulfillment of the Requirements
for the Degree Master of Science

By

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1959

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
GENERAL DISCUSSION OF METHROGON ACCURACY	2
VERIFYING THE CURVE OF THE METHROGON CORRECTION PLATES	25
CONSTRUCTION OF COORDINATE ERROR CURVES	68
CONCLUSION	113

TABLE OF CONTENTS

Page

I	INTRODUCTION	1
II	GENERAL CONCEPTS OF KNOWLEDGE	11
III	THEORY OF KNOWLEDGE	21
IV	TECHNIQUES OF KNOWLEDGE	31
V	CONCLUSION	41

INTRODUCTION

The purpose of this thesis is to determine, by computation, the accuracy limitations of metrogon photography for use in stereo plotting instruments such as the Wild Autograph A7. This will be done by analyzing the error curves of lenses for which data can be obtained. These data will then be compared to a standard metrogon correction plate curve, as verified by observation, to determine residual errors. Then error curves within the stereo model will be constructed for X and Z coordinates and a y-parallax curve determined. Error curves from observation of an actual set of metrogon photographs will then be constructed and compared with the computed curves.

[illegible]

GENERAL DISCUSSION OF METROGON ACCURACY

In order to discuss the accuracy of metrogon photography, several letters were written to governmental agencies and metrogon lens manufacturers requesting data on these lenses. The only reply received with any usable information was from the National Bureau of Standards, enclosing data on all (25) metrogon lenses tested during fiscal year 1959.

The distortion values, which were taken from the original data, are tabulated in microns, normally the Bureau reports distortion values to the nearest ± 0.02 mm. These lenses were tested at their maximum aperture, f/6.3, and the measurements were made with a collimated incident light using a K-3 filter, a tungsten source and Eastman Kodak spectroscopic emulsion type V-F. Development was done in D-19 at 66°F for three minutes with continuous agitation. Tables I, II, and III are the tables of data provided by the National Bureau of Standards.

The data in Tables II and III are based on angular displacement from the principal point. This data was converted to radial distances in Table IV in order to provide a basis of comparison with the correction plate. The data of Tables III and IV were then used to construct the distortion curves of the best, average, and worst lenses, in Figures 5 through 8. These curves indicate the displacement of the image from the distortion free

THEORY OF THE EARTH'S CRUST

It is well known that the crust of the earth is composed of various layers of different materials. The uppermost layer is the crust proper, which is composed of igneous, sedimentary, and metamorphic rocks. Below the crust proper is the mantle, which is composed of igneous and metamorphic rocks. The lowermost layer is the core, which is composed of iron and nickel. The crust proper is the layer of the earth's crust that is exposed at the surface. It is the layer of the earth's crust that is composed of igneous, sedimentary, and metamorphic rocks. The mantle is the layer of the earth's crust that is below the crust proper. It is the layer of the earth's crust that is composed of igneous and metamorphic rocks. The core is the layer of the earth's crust that is below the mantle. It is the layer of the earth's crust that is composed of iron and nickel.

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position. The abscissa indicates radial distance of the distortion free position from the photo center. A positive distortion value indicates a displacement away from center.

There has been considerable discussion concerning the establishment of a standardized calibrated focal length for metrogon lenses. Insofar as could be determined, there has been no formalized decision on this matter. It is apparent from the reconstructed curves of the 25 lenses that the National Bureau of Standards has adopted the calibrated focal length to produce zero distortion at the $42\frac{1}{2}^{\circ}$ circle, as all curves plot out through this point.

Table V is a table of lens distortions, based on radial distance in mm, taken from the reconstructed curves of distortion of the lenses. Figure 9 is the distortion compensation curve of the correction plate manufactured by Wild. The offset abscissa chosen for construction of the plates was used in order to reduce the thickness of glass. The shifted abscissa requires that the calibrated focal length of metrogon plates used with the correction plates must be increased by 0.066 mm. However the values, taken in reference to the original abscissa, can be used for comparison with curves of lenses whose calibrated focal length is set for zero distortion at $42\frac{1}{2}^{\circ}$.

After a comparison of the correction plate curve with the curves of distortion of the lenses, the amount of distortion which the correction plates would leave uncompensated was tabulated in Table VI. It is realized that 25 lenses is a small sampling of the number which has been manufactured. However, this is the entire

number submitted to the National Bureau of Standards, for testing, over a one year period, regardless of manufacturer or source. With this in mind, it is interesting to note that only two lenses (8%) have distortion curves sufficiently close to the correction plate curve, which is apparently a fairly widely accepted standard curve, to provide uncompensated errors less than ± 10 microns. Thirteen (62%) would have uncompensated errors less than ± 20 microns. Two (8%) of the lenses would have uncompensated errors in excess of 40 microns.

In order to determine the effect the above errors would have on a stereo model, an assumed elevation of 4,000 meters above terrain was chosen and elevation errors were computed using the basic relief displacement relationship, $d = rh \frac{p}{H}$ for computing an approximate elevation discrepancy which would result from the values in Table VI. This approximation is undoubtedly accurate enough for the number of significant digits used. These values, tabulated in Table VII, would not necessarily be the errors measured in a stereo model, as they would depend on the relative orientation achieved which in turn would depend upon the location of the chosen orientation points. This is true because, except along the line through the two principal points, the lens distortion will cause a varying amount of y-parallax. If this parallax is removed at the orientation points, the projected images will not have the true spatial relationship, and the effects of lens distortion at any given point in the model may be exaggerated or diminished

1. The first step in the process of identifying a problem is to determine the nature of the problem. This involves a thorough understanding of the situation and the people involved. It is important to gather as much information as possible about the problem, including its history, its current status, and the interests of the people involved. This information will be used to develop a clear and concise statement of the problem.

depending on the specific case. On the other hand, if the distortion at the chosen orientation points which are not on the line connecting the principal points happens to be zero from both projectors, the relative orientation will be true and the lens distortion will have full effect.

The values in Table VI will be the maximum possible elevation error at any given point, that is the larger of the two elevation errors at that point will be the maximum. This can be best demonstrated by diagramming the relationship of true and distorted rays at a point along the line connecting the principal points, as in Figure 1.

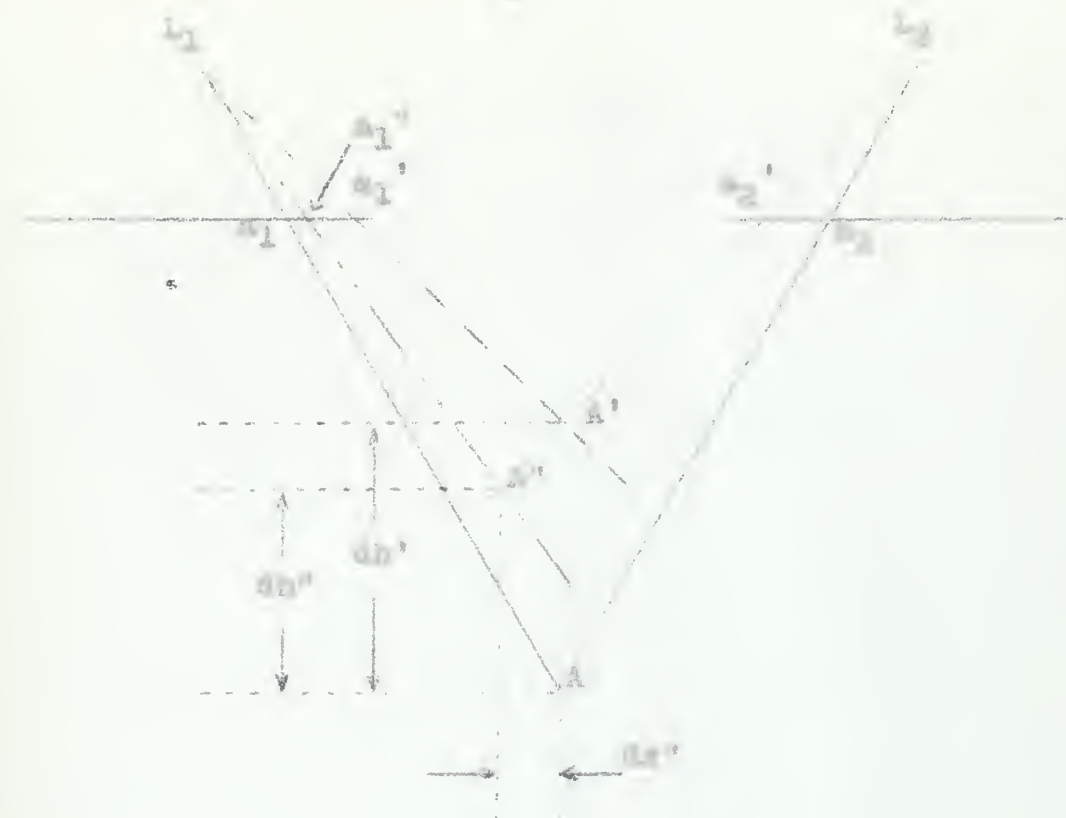
As can be seen from Figure 1, the maximum elevation error occurs when the elevation errors at a given point are equal which is true along the line equidistant from both principal points, and there will be an error in the X direction whenever the elevation errors are unequal. The same thing occurs at points which are not equidistant from both principal points or on lines through L_1 and L_2 parallel to this line, except that y-parallax is introduced. This can be seen in Figure 2. In Figure 2, point A" is not actually a point of intersection as the two rays pass through the vertical line through A-A' at different points. A" is the point on both lines at which there is no X or elevation separation and thus is the point which would be chosen in a stereo instrument as the true point with only y-parallax present. Actually, the ray from L_1 is in front of the ray from L_2 , as Figure 1 is drawn. The range of possible y positions in a stereo instrument would be between points

the following is a list of the names of the persons who have been appointed to the various positions in the organization of the National Association of Manufacturers, as of January 1, 1914.

1. The first step in the process of identifying a problem is to define the problem. This involves identifying the symptoms of the problem and determining the scope of the problem. Once the problem has been defined, the next step is to identify the causes of the problem. This involves identifying the factors that are contributing to the problem and determining the underlying causes. Once the causes have been identified, the next step is to develop a plan of action. This involves identifying the steps that need to be taken to solve the problem and determining the resources that will be needed to implement the plan. Once a plan of action has been developed, the final step is to implement the plan. This involves carrying out the steps that have been identified in the plan and monitoring the progress of the implementation.

[illegible]

It is important to note that the results of this study are based on a cross-sectional design, which limits the ability to establish causality. Future research should employ longitudinal designs to investigate the temporal relationships between the variables studied.



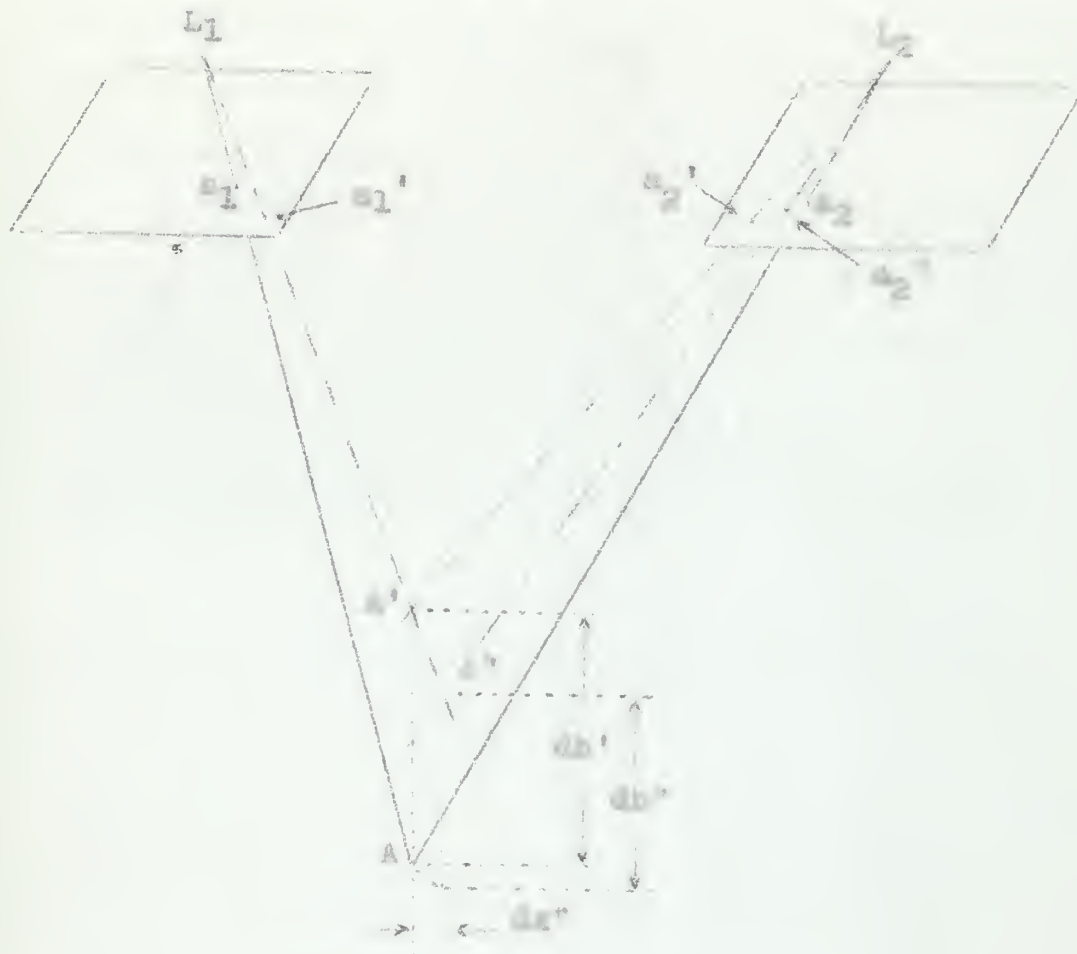
————	True rays
— · — · —	Distorted rays of equal elevation error
— · — · —	Distorted ray of unequal elevation error to ray from right projector
$a_1 a_2$	undistorted positions
$a_1' a_2'$	equally distorted positions
$a_1'' a_2'$	unequally distorted positions
A	true projected image
A'	projected image with equal distortions
A''	projected image with unequal distortions
dh'	elevation error with equal distortions
dh''	elevation error with unequal distortions
dx''	X error with unequal distortions

Figure 1

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Journal of Management Inquiry 22(1) 3-14

	Small Redwing	7
	Swainson's Thrush	1
	Whitethroated Sparrow	1
	Willow Warbler	1
	Wren Tit	1
	Yellow Warbler	1



Symbols as used in Figure 1

Figure 2

A'' on rays from L_1 and L_2 . The exact position would depend on the relative orientation procedure. The point will be displaced by dx'' which will be zero in the event of equal elevation errors from both projectors, as at point A' .

There will be no X displacement of the image along a line equidistant from both principal points or lines through L_1 and L_2 parallel to this line as the points along the equidistant line will

There will be no representation of the State in the
proceedings of the Commission. The Commission will be
composed of the following members:

have equal distortion and thus equal elevation error at any given point along it, and the projection from either point parallel to the y -axis will have no X displacement.

As can be seen from Figures 1 and 2, the X displacement will always be toward the projector having the lowest (algebraically) elevation error at the point in question. The magnitude of the X displacement is computed as follows:

A drawing of a horizontal projection of the rays involved onto a plane containing both camera axes is constructed.

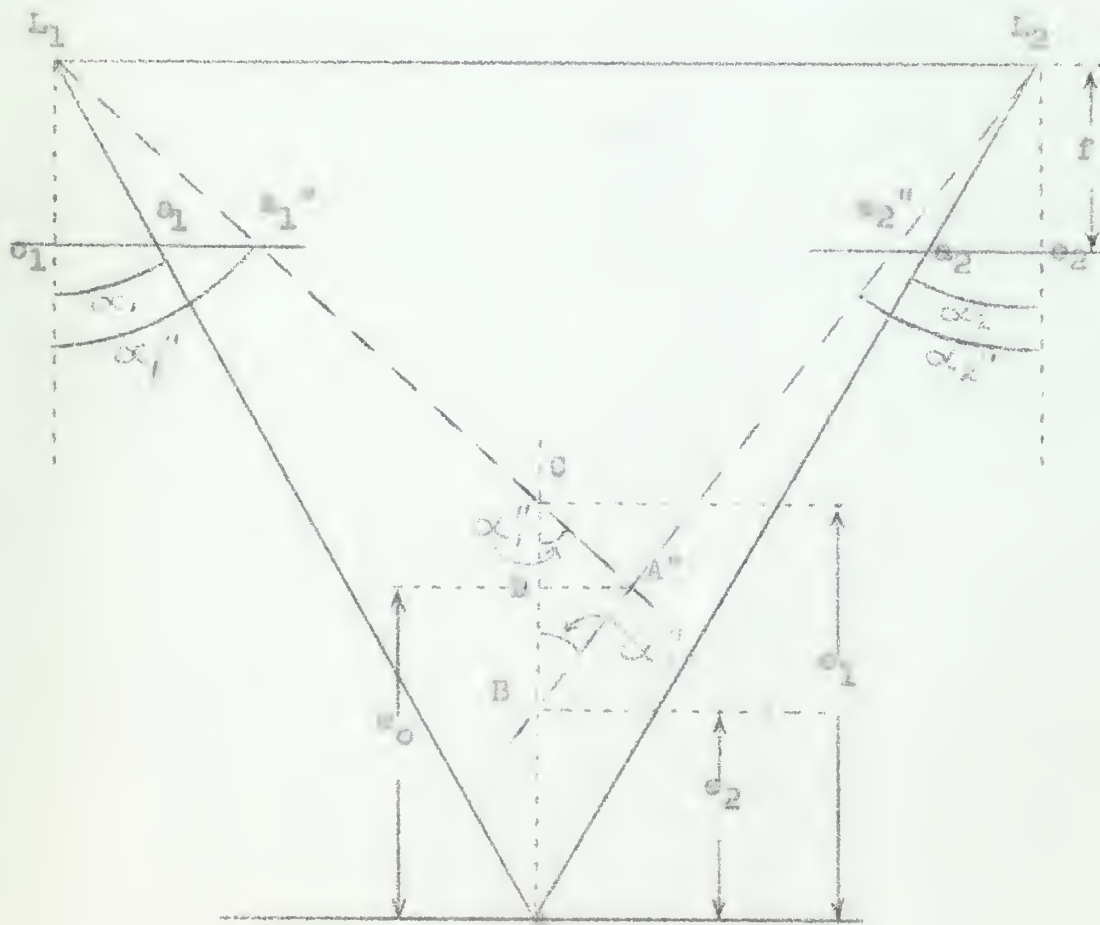


Figure 3

and the other two sides of the triangle are equal to the sides of the triangle ABC , and the included angle is equal to the included angle of the triangle ABC , and the two triangles are congruent.

It is now to be shown that the two triangles are congruent. The first of the two triangles is the triangle ABC , and the second is the triangle DEF . The two triangles are congruent because the two sides of the triangle ABC are equal to the two sides of the triangle DEF , and the included angle is equal to the included angle.

A line is drawn from the vertex A of the triangle ABC to the vertex D of the triangle DEF , and the two triangles are congruent.



$$A_1 B_1 = A_2 B_2 = \dots = A_n B_n = \dots = A_\infty B_\infty = \dots = A B$$

$$\frac{A_1 B_1}{A_1 B_2} = \frac{A_2 B_1}{A_2 B_2} = \dots = \frac{A_n B_1}{A_n B_2} = \dots = \frac{A_\infty B_1}{A_\infty B_2} = \dots = \frac{A B_1}{A B_2}$$

$$\frac{A_1 B_1}{A_1 B_2} = \frac{A_2 B_1}{A_2 B_2} = \dots = \frac{A_n B_1}{A_n B_2} = \dots = \frac{A_\infty B_1}{A_\infty B_2} = \dots = \frac{A B_1}{A B_2}$$

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The above is the definition of the limit of a sequence of points. The above is the definition of the limit of a sequence of points. The above is the definition of the limit of a sequence of points.



$DA'' = dX''$ (as shown in Figure 3)

$$A''A_2'' = dX'' \tan \beta_2 = \frac{y_{a_2} dX''}{-x_{a_2}} \quad A''A_1'' = dX'' \tan \beta_1 = \frac{y_{a_1} dX''}{x_{a_1}}$$

$$A''A_2'' = \frac{y_{a_2}}{-x_{a_2}} \left[\frac{-x_{a_1} x_{a_2} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})} \right] = \frac{x_{a_1} y_{a_2} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})}$$

$$A''A_1'' = \frac{y_{a_1}}{x_{a_1}} \left[\frac{-x_{a_1} x_{a_2} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})} \right] = \frac{-x_{a_2} y_{a_1} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})}$$

Thus:

$$\text{total parallax } A_1''A_2'' = \frac{x_{a_1} y_{a_2} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})} - \frac{x_{a_2} y_{a_1} (e_1 - e_2)}{f(x_{a_1} - x_{a_2})}$$

$$A_1''A_2'' = \frac{(e_1 - e_2)(x_{a_1} y_{a_2} - x_{a_2} y_{a_1})}{f(x_{a_1} - x_{a_2})} \quad (\text{at ground scale})$$

$$\text{at photo scale } py = \frac{f}{H-h} A_1''A_2'' = \frac{(e_1 - e_2)(x_{a_1} y_{a_2} - x_{a_2} y_{a_1})}{(H-h)(x_{a_1} - x_{a_2})}$$

A plus sign in py indicates that A_2'' is in a positive Y direction from A_1'' .

An example using lens number 25 and assuming a 100 mm base length, with the point of detail 40 mm from station 1 and 60 mm from station 2 along the line between principal points, is presented. In the case of points not on this line, bear in mind that true radial distance from the principal point must be used to determine elevation error, and this distance will differ from the values of x_{a_1} and x_{a_2} .

$$x_{a_1} = 40 \text{ mm} \quad x_{a_2} = 60 \text{ mm} \quad e_1 = 1.3 \text{ m} \quad e_2 = 0.48 \text{ m}$$

$$f = 153.80 \text{ mm}$$

$$py = \frac{(1.3 - 0.48)(40 \pm 0 - 60 \pm 0)}{4000(40 - 60)} = 0 \text{ as the point is along the line between principal points.}$$

$$dx'' = \frac{(40)(60)(1.3 - 0.48)}{(153.80)(40 + 60)} = 0.128 \text{ m at natural scale.}$$

The magnitude of the resultant elevation error can also be computed using Figure 3 as a reference.

$$AD = e_o \text{ (resultant elevation error)} = AB + BD$$

$$AB = e_2 \quad BD = dx'' \cot \alpha_2''$$

$$\cot \alpha_2'' = f / -x_{a_2}$$

$$BD = \frac{f dx''}{-x_{a_2}}$$

$$\text{Thus: } e_o = e_2 - \frac{f dx''}{x_{a_2}}$$

Using the example of lens number 25:

$$e_o = 0.48 - \frac{153.80 \times 0.128}{-60} = 0.81 \text{ m}$$

The signs of x_{a_1} , x_{a_2} , y_{a_1} , y_{a_2} are as measured in a photo scale model (positive print) for the above derivations. The above computational procedures are applicable to all types of photography once the curve of elevation errors due to distortion has been determined. Thus the elevation error and the X displacement caused by lens distortion can be computed for any given point in the stereo model. This condition, of course, will only be the true situation

$$a(0,0) = \frac{1}{2} \quad a(1,1) = \frac{1}{2} \quad a(0,1) = \frac{1}{2} \quad a(1,0) = \frac{1}{2}$$

$$a(0,0) = \frac{1}{2}$$

$$a(1,1) = \frac{1}{2} \quad a(0,1) = \frac{1}{2} \quad a(1,0) = \frac{1}{2}$$

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$$a(1,0) = \frac{1}{2}$$

if the relative orientation has been completed so that a true spatial model has been developed.

In the above example, presume that the elevation variation of the terrain is 10% of the flying height above the terrain. Because the values of e_1 and e_2 are directly proportional to the flying heights, and e_o and dx'' are directly proportional to first order equations containing e_1 and e_2 , the values will vary 10% of the computed value, thus:

<u>Qty</u>	<u>Computed Value</u>	<u>10% Variation</u>
e_o	0.81 m	0.73 to 0.89 m
dx''	0.128 m	0.115 to 0.141 m

Therefore the accuracy of elevation computation would be one part in 50,000 of the flying height, and the accuracy of the X coordinate would be one part in 300,000 of the flying height.

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TABLE I

FOCAL LENGTHS

Lens No.	Equivalent Focal Length	Calibrated Focal Length
	mm	mm
1	152.67	152.77
2	153.39	153.45
3	154.31	154.31
4	153.86	153.85
5	151.85	151.90
6	154.34	154.37
7	151.70	151.70
8	152.94	152.95
9	154.34	154.34
10	153.19	153.22
11	153.33	153.30
12	153.73	153.70
13	153.67	153.75
14	152.58	152.62
15	153.19	153.20
16	153.36	153.30
17	152.79	152.76
18	153.72	153.68
19	153.81	153.80
20	155.37	155.35
21	153.98	153.89
22	153.40	153.36
23	154.22	154.19
24	152.54	152.49
25	153.90	153.80
Ave.		153.44

The probable errors of these determinations of focal length do not exceed ± 0.10 mm.

TABLE 1

FISH CATCHES

Year	Total catch	Per cent of total
1900	10,000	100
1901	11,000	110
1902	12,000	120
1903	13,000	130
1904	14,000	140
1905	15,000	150
1906	16,000	160
1907	17,000	170
1908	18,000	180
1909	19,000	190
1910	20,000	200
1911	21,000	210
1912	22,000	220
1913	23,000	230
1914	24,000	240
1915	25,000	250
1916	26,000	260
1917	27,000	270
1918	28,000	280
1919	29,000	290
1920	30,000	300
1921	31,000	310
1922	32,000	320
1923	33,000	330
1924	34,000	340
1925	35,000	350
1926	36,000	360
1927	37,000	370
1928	38,000	380
1929	39,000	390
1930	40,000	400
1931	41,000	410
1932	42,000	420
1933	43,000	430
1934	44,000	440
1935	45,000	450
1936	46,000	460
1937	47,000	470
1938	48,000	480
1939	49,000	490
1940	50,000	500
1941	51,000	510
1942	52,000	520
1943	53,000	530
1944	54,000	540
1945	55,000	550
1946	56,000	560
1947	57,000	570
1948	58,000	580
1949	59,000	590
1950	60,000	600
1951	61,000	610
1952	62,000	620
1953	63,000	630
1954	64,000	640
1955	65,000	650
1956	66,000	660
1957	67,000	670
1958	68,000	680
1959	69,000	690
1960	70,000	700
1961	71,000	710
1962	72,000	720
1963	73,000	730
1964	74,000	740
1965	75,000	750
1966	76,000	760
1967	77,000	770
1968	78,000	780
1969	79,000	790
1970	80,000	800
1971	81,000	810
1972	82,000	820
1973	83,000	830
1974	84,000	840
1975	85,000	850
1976	86,000	860
1977	87,000	870
1978	88,000	880
1979	89,000	890
1980	90,000	900
1981	91,000	910
1982	92,000	920
1983	93,000	930
1984	94,000	940
1985	95,000	950
1986	96,000	960
1987	97,000	970
1988	98,000	980
1989	99,000	990
1990	100,000	1000

The figures shown are based on the following assumptions:

1. The catch in 1900 was 10,000 tons.

TABLE II

DISTORTION REFERRED TO THE EQUIVALENT FOCAL LENGTH IN MICRONS

Lens No.	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
1	0	-2	1	13	38	76	126	173	172	9
2	0	-2	2	12	31	65	119	164	142	-74
3	0	-1	1	10	30	60	96	119	81	-120
4	0	-2	1	12	31	62	92	108	62	-128
5	0	-2	2	16	34	70	107	140	113	-63
6	0	-2	2	13	22	64	96	132	110	-80
7	0	-2	2	12	34	65	96	115	70	-120
8	0	-2	2	14	34	64	100	130	100	-104
9	0	0	0	11	32	61	99	123	96	-120
10	0	-2	2	13	30	71	114	146	120	-92
11	0	-2	2	6	33	73	112	146	116	-89
12	0	-3	2	10	30	60	92	110	62	-150
13	0	-3	2	9	28	61	103	158	172	-10
14	0	-2	1	14	36	72	109	140	115	-82
15	0	-2	2	13	33	67	100	119	89	-97
16	0	-1	0	10	28	50	74	86	34	-184
17	0	0	0	10	30	56	87	102	56	-153
18	0	-1	1	11	26	52	77	95	35	-163
19	0	-1	1	13	30	58	94	121	83	-135
20	0	-1	-2	10	28	57	97	119	77	-154
21	0	-3	2	12	28	49	74	77	11	-227
22	0	-4	3	10	29	52	80	94	49	-161
23	0	-2	2	12	34	63	94	110	62	-148
24	0	-1	1	8	36	66	88	94	40	-174
25	0	0	0	8	19	42	60	61	-1	-220
Average	0	-2	1	11	31	62	95	119	63	-122

[illegible]

TABLE III

DISTORTION REFERRED TO THE CALIBRATED FOCAL LENGTH IN MICRONS

Lens No.	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
1	0	-11	-18	-15	0	27	65	98	84	-98
2	0	-6	-7	-2	12	44	89	127	98	-127
3	0	-1	1	10	30	60	96	119	81	-120
4	0	-1	3	15	35	67	98	116	71	-116
5	0	-6	-6	4	18	49	81	108	75	-108
6	0	-5	-3	5	11	50	79	111	85	-110
7	0	-2	3	13	36	67	99	116	74	-116
8	0	-3	-1	10	29	57	91	120	87	-119
9	0	0	0	11	32	61	99	123	96	-120
10	0	-5	-3	5	19	56	96	124	94	-124
11	0	-5	-4	-2	21	58	93	123	88	-123
12	0	-1	6	16	38	71	105	126	82	-126
13	0	-10	-13	-14	-3	21	53	97	100	-97
14	0	-5	-4	5	23	57	90	116	87	-116
15	0	-3	0	10	29	61	93	110	79	-110
16	0	4	10	25	49	77	107	126	82	-126
17	0	3	5	18	41	70	104	123	81	-123
18	0	3	8	22	41	71	100	123	69	-123
19	0	0	3	15	33	62	99	128	89	-127
20	0	1	2	15	35	66	109	133	94	-134
21	0	4	17	35	59	89	123	137	82	-139
22	0	0	10	21	44	71	103	122	83	-122
23	0	0	6	18	42	73	107	125	80	-125
24	0	3	9	20	52	87	114	125	79	-125
25	0	8	16	32	52	85	114	126	79	-126
Average	0	-2	2	12	31	62	96	120	84	-120

The values of the distortion are measured in microns and indicate the displacement of the image from its distortion-free position. A positive value indicates a displacement from the center of the plate. The probable error does not exceed ± 10 microns.

TABLE IV
RADIAL DISTANCES BASED ON FOCAL LENGTHS IN MM

Lens	2°	5°	10°	15°	20°	25°	30°	35°	40°	42.5°
1	152.77	13.37	25.94	40.93	55.60	71.24	86.20	106.97	126.19	139.99
2	153.45	13.43	27.06	41.12	55.85	71.55	86.59	107.45	126.76	140.61
3	154.31	13.50	27.21	41.35	56.16	71.96	89.09	108.05	129.46	141.40
4	153.85	13.46	27.13	41.22	56.00	71.74	86.83	107.73	129.10	140.98
5	151.90	13.29	26.78	40.70	55.29	70.83	87.70	106.36	127.46	139.19
6	154.37	13.51	27.22	41.36	56.19	71.98	89.13	108.09	129.53	141.45
7	151.70	13.27	26.75	40.65	55.21	70.74	87.58	106.22	127.29	139.01
8	152.95	13.38	26.97	40.90	55.67	71.32	86.31	107.10	126.34	140.15
9	154.34	13.50	27.21	41.36	56.18	71.97	89.11	108.07	129.51	141.43
10	153.22	13.41	27.02	41.06	55.77	71.45	88.46	107.29	128.57	140.40
11	153.30	13.41	27.03	41.06	55.80	71.49	88.51	107.34	128.63	140.47
12	153.79	13.45	27.10	41.18	55.94	71.67	88.74	107.62	128.97	140.84
13	153.75	13.45	27.11	41.20	55.96	71.69	88.77	107.66	129.01	140.89
14	152.62	13.35	26.91	40.99	55.55	71.17	88.12	106.87	126.66	139.65
15	153.20	13.40	27.01	41.05	55.76	71.44	88.45	107.27	128.59	140.39
16	153.30	13.41	27.03	41.06	55.80	71.49	88.51	107.34	128.63	140.47
17	152.76	13.36	26.94	40.93	55.60	71.23	86.20	106.96	128.16	139.96
18	153.68	13.45	27.10	41.16	55.93	71.66	88.73	107.61	128.95	140.82
19	153.80	13.46	27.12	41.21	55.98	71.72	88.80	107.69	129.05	140.93
20	155.35	13.59	27.39	41.63	56.54	72.44	89.69	108.78	130.35	142.35
21	153.89	13.46	27.13	41.23	56.01	71.76	88.85	107.76	129.13	141.01
22	153.36	13.42	27.04	41.09	55.82	71.51	88.54	107.36	128.68	140.53
23	154.19	13.49	27.19	41.32	56.12	71.90	89.02	107.97	129.38	141.29
24	152.49	13.34	26.89	40.86	55.50	71.11	88.04	106.77	127.95	139.73
25	153.80	13.46	27.12	41.21	55.96	71.72	88.80	107.69	129.05	140.93
Ave.	153.44	13.43	27.06	41.12	55.85	71.55	88.56	107.45	128.75	140.60

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TABLE V
TABLE OF LENS DISTORTIONS IN MICRONS TAKEN FROM RECONSTRUCTED CURVES

Lens	20 mm	40 mm	60 mm	80 mm	100 mm	120 mm	140 mm	150 mm
1	-14.4	-15.5	+ 6.0	+ 46.0	+ 89.2	+100.0	0	- 77.0
2	- 6.8	- 2.8	+16.2	+ 66.3	+117.1	+120.7	+ 5.0	- 93.3
3	- 0.4	+ 8.6	+36.5	+ 70.2	+112.2	+109.8	+13.2	- 78.6
4	+ 0.1	+13.7	+42.0	+ 83.1	+113.6	+101.0	+ 3.0	- 84.0
5	- 6.8	+ 3.7	+25.9	+ 66.7	+103.0	+ 94.6	- 7.0	- 93.0
6	- 4.7	+ 4.1	+15.0	+ 66.0	+102.0	+105.0	+13.0	- 72.0
7	- 0.2	+12.6	+46.0	+ 85.0	+113.2	+102.3	- 9.6	-100.0
8	- 3.0	+ 8.4	+36.6	+ 73.4	+114.5	+110.6	+ 3.5	- 91.2
9	0	+ 9.0	+38.4	+ 78.0	+118.0	+117.8	+13.0	- 80.0
10	- 4.8	+ 4.1	+28.5	+ 76.4	+118.3	+116.0	+ 4.0	- 92.0
11	- 4.8	- 2.2	+30.7	+ 76.5	+114.0	+113.0	+ 4.3	- 91.0
12	+ 1.5	+14.8	+46.4	+ 87.5	+122.2	+114.5	+ 7.0	- 93.0
13	-12.2	-14.3	+ 1.8	+ 36.4	+ 77.5	+117.3	- 6.7	- 89.0
14	- 5.2	+ 3.8	+31.2	+ 74.5	+110.0	+107.5	- 2.3	- 93.0
15	- 2.8	+ 9.3	+36.2	+ 78.0	+107.0	+100.4	+ 3.0	- 81.7
16	+ 5.7	+23.3	+54.5	+ 92.8	+122.2	+112.5	+ 3.3	- 92.3
17	+ 3.0	+16.6	+49.5	+ 86.0	+120.0	+110.4	- 0.5	- 96.2
18	+ 4.8	+20.3	+48.0	+ 86.0	+116.0	+101.0	+ 4.8	- 85.0
19	+ 0.4	+13.3	+40.9	+ 79.4	+122.5	+119.0	+ 8.0	- 90.0
20	0	+12.9	+41.0	+ 83.0	+128.0	+125.0	+24.0	- 79.0
21	+ 9.7	+33.0	+66.2	+106.3	+135.4	+122.0	+ 8.0	- 96.0
22	+ 4.2	+19.7	+51.0	+ 86.4	+118.2	+111.3	+ 4.0	- 82.3
23	+ 2.0	+16.5	+48.8	+ 89.5	+121.5	+113.5	+11.0	- 83.2
24	+ 5.6	+19.0	+64.0	+102.2	+125.3	+105.0	- 3.0	-100.0
25	+11.9	+30.0	+58.2	+101.5	+123.8	+111.5	+ 6.7	- 89.5
Ave.	- 0.7	+11.2	+39.0	+ 79.0	+115.6	+109.0	+ 5.8	- 88.0

TABLE VI
TABLE OF DISTORTION, IN MICRONS, REMAINING UNCOMPENSATED BY PLATES

Lens	20 mm	40 mm	60 mm	80 mm	100 mm	120 mm	140 mm	150 mm
1	-16.4	-32.5	-45.0	-44.0	-26.8	-1.0	-10.0	-1.0
2	-8.8	-19.8	-34.8	-23.7	+1.1	+19.7	-5.0	-17.0
3	-2.4	-8.4	-14.5	-11.8	-3.8	+8.8	+3.2	-2.8
4	-1.9	-3.3	-9.0	-6.9	-2.4	0	-7.0	-8.0
5	-8.8	-13.3	-25.1	-23.3	-13.0	-6.4	-17.0	-17.0
6	-6.7	-12.9	-36.0	-24.0	-14.0	+4.0	+3.0	+4.0
7	-2.2	-4.4	-5.0	-5.0	-2.8	+1.3	-19.6	-24.0
8	-5.0	-8.6	-14.4	-16.6	-1.5	+9.6	-6.5	-15.2
9	-2.0	-8.0	-12.6	-12.0	+2.0	+16.8	+3.0	-4.0
10	-6.8	-12.9	-22.5	-13.6	+2.3	+15.0	-6.0	-16.0
11	-6.8	-19.2	-20.3	-13.5	-2.0	+12.0	-5.7	-15.0
12	-0.5	-2.2	-4.6	-2.5	+6.2	+13.5	-3.0	-17.0
13	-14.2	-31.3	-49.2	-53.6	-38.5	+16.3	-3.3	+7.0
14	-7.2	-13.2	-19.8	-15.5	-6.0	+6.5	-12.3	-17.0
15	-4.8	-6.7	-14.8	-12.0	-9.0	-0.6	-7.0	-5.7
16	+3.7	+6.3	+3.5	+2.8	+6.2	+11.5	-6.7	-16.3
17	+1.0	-0.4	-1.5	-4.0	+4.0	+9.4	-10.5	-22.2
18	+2.8	+3.3	-3.0	-4.0	0	0	-5.2	-9.0
19	-1.6	-3.7	-10.1	-10.6	+6.5	+18.0	-2.0	-14.0
20	-2.0	-4.1	-10.0	-7.0	+12.0	+24.0	+14.0	-3.0
21	+7.7	+16.0	+15.2	+16.3	+19.4	+21.0	-2.0	-22.0
22	+2.2	+2.7	0	-3.6	+2.2	+10.3	-6.0	-6.3
23	0	-0.5	-2.2	-0.5	+5.5	+12.5	+1.0	-7.2
24	+3.6	+2.0	+13.0	+12.2	+9.3	+4.0	-13.0	-24.0
25	+9.9	+13.0	+7.2	+11.5	+7.8	+10.5	-3.3	-13.5
Ave.	-2.7	-5.6	-12.0	-11.0	-0.4	+8.0	-4.2	-12.0

TABLE VII
TABLE OF ELEVATION ERRORS IN METERS

Lens	20 mm	40 mm	60 mm	80 mm	100 mm	120 mm	140 mm	150 mm
1	-3.28	-3.25	-3.00	-2.20	-1.07	-0.03	-0.29	-0.03
2	-1.76	-1.98	-2.32	-1.18	+0.04	+0.66	-0.14	-0.45
3	-0.48	-0.84	-0.97	-0.59	-0.15	+0.29	+0.09	-0.07
4	-0.38	-0.33	-0.60	-0.35	-0.10	0	-0.20	-0.21
5	-1.76	-1.33	-1.67	-1.16	-0.52	-0.21	-0.49	-0.45
6	-1.34	-1.29	-2.40	-1.20	-0.56	+0.13	+0.09	+0.11
7	-0.44	-0.44	-0.33	-0.25	-0.11	+0.04	-0.56	-0.64
8	-1.00	-0.86	-0.96	-0.83	-0.06	+0.32	-0.19	-0.41
9	-0.40	-0.80	-0.84	-0.60	+0.08	+0.56	+0.09	-0.11
10	-1.36	-1.29	-1.50	-0.68	-0.09	+0.50	-0.17	-0.43
11	-1.36	-1.92	-1.35	-0.68	-0.06	+0.40	-0.16	-0.40
12	-0.10	-0.22	-0.31	-0.12	-0.25	+0.45	-0.09	-0.45
13	-2.84	-3.13	-3.28	-2.68	-1.54	+0.55	-0.09	+0.19
14	-1.44	-1.32	-1.32	-0.78	-0.24	+0.22	-0.35	-0.45
15	-0.96	-0.67	-0.98	-0.60	-0.36	-0.02	-0.20	-0.15
16	+0.74	+0.63	+0.23	+0.14	+0.25	+0.35	-0.19	-0.43
17	+0.20	-0.04	-0.10	-0.20	+0.16	+0.31	-0.30	-0.59
18	+0.56	+0.33	-0.20	-0.20	0	0	-0.15	-0.24
19	-0.32	-0.37	-0.67	-0.53	+0.26	+0.60	-0.06	-0.37
20	-0.40	-0.41	-0.67	-0.35	+0.48	+0.80	+0.40	-0.06
21	+1.54	+1.60	-1.01	+0.82	+0.78	+0.70	-0.06	-0.59
22	+0.44	+0.27	0	-0.18	+0.09	+0.34	-0.17	-0.17
23	0	-0.05	-0.14	-0.03	+0.22	+0.42	+0.03	-0.19
24	+0.72	+0.20	+0.87	+0.61	+0.38	+0.13	-0.37	-0.64
25	+1.98	+1.30	+0.48	+0.58	+0.31	+0.35	-0.09	-0.36
Ave.	-0.54	-0.58	-0.80	-0.55	-0.02	+0.27	-0.12	-0.32

1	1947-1948	1947-1948
2	1948-1949	1948-1949
3	1949-1950	1949-1950
4	1950-1951	1950-1951
5	1951-1952	1951-1952
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14	1960-1961	1960-1961
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18	1964-1965	1964-1965
19	1965-1966	1965-1966
20	1966-1967	1966-1967
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23	1969-1970	1969-1970
24	1970-1971	1970-1971
25	1971-1972	1971-1972
26	1972-1973	1972-1973
27	1973-1974	1973-1974
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33	1979-1980	1979-1980
34	1980-1981	1980-1981
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50	1996-1997	1996-1997
51	1997-1998	1997-1998
52	1998-1999	1998-1999
53	1999-2000	1999-2000
54	2000-2001	2000-2001
55	2001-2002	2001-2002
56	2002-2003	2002-2003
57	2003-2004	2003-2004
58	2004-2005	2004-2005
59	2005-2006	2005-2006
60	2006-2007	2006-2007
61	2007-2008	2007-2008
62	2008-2009	2008-2009
63	2009-2010	2009-2010
64	2010-2011	2010-2011
65	2011-2012	2011-2012
66	2012-2013	2012-2013
67	2013-2014	2013-2014
68	2014-2015	2014-2015
69	2015-2016	2015-2016
70	2016-2017	2016-2017
71	2017-2018	2017-2018
72	2018-2019	2018-2019
73	2019-2020	2019-2020
74	2020-2021	2020-2021
75	2021-2022	2021-2022
76	2022-2023	2022-2023
77	2023-2024	2023-2024
78	2024-2025	2024-2025
79	2025-2026	2025-2026
80	2026-2027	2026-2027
81	2027-2028	2027-2028
82	2028-2029	2028-2029
83	2029-2030	2029-2030
84	2030-2031	2030-2031
85	2031-2032	2031-2032
86	2032-2033	2032-2033
87	2033-2034	2033-2034
88	2034-2035	2034-2035
89	2035-2036	2035-2036
90	2036-2037	2036-2037
91	2037-2038	2037-2038
92	2038-2039	2038-2039
93	2039-2040	2039-2040
94	2040-2041	2040-2041
95	2041-2042	2041-2042
96	2042-2043	2042-2043
97	2043-2044	2043-2044
98	2044-2045	2044-2045
99	2045-2046	2045-2046
100	2046-2047	2046-2047

1947-1948

1947-1948

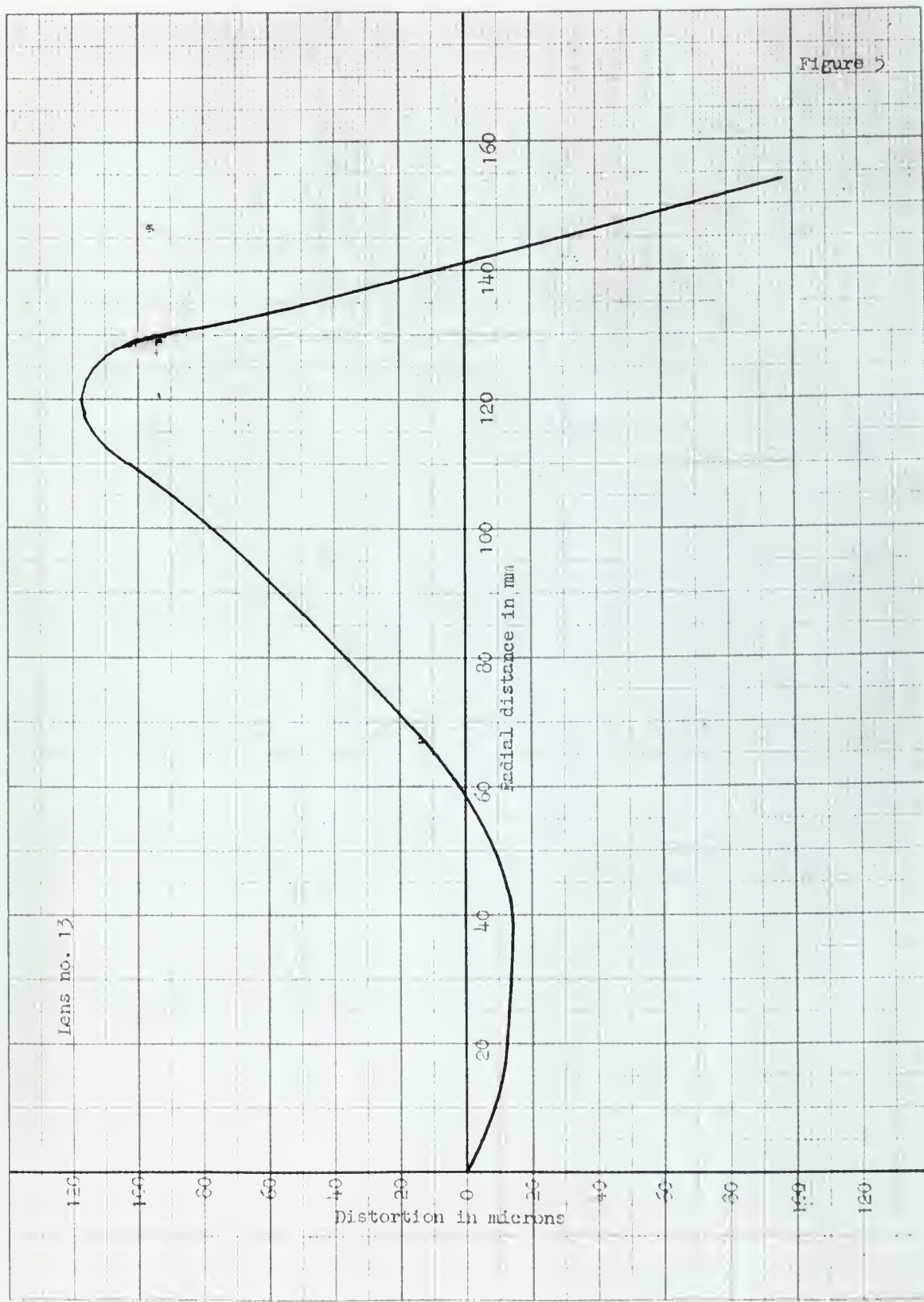


Figure 7

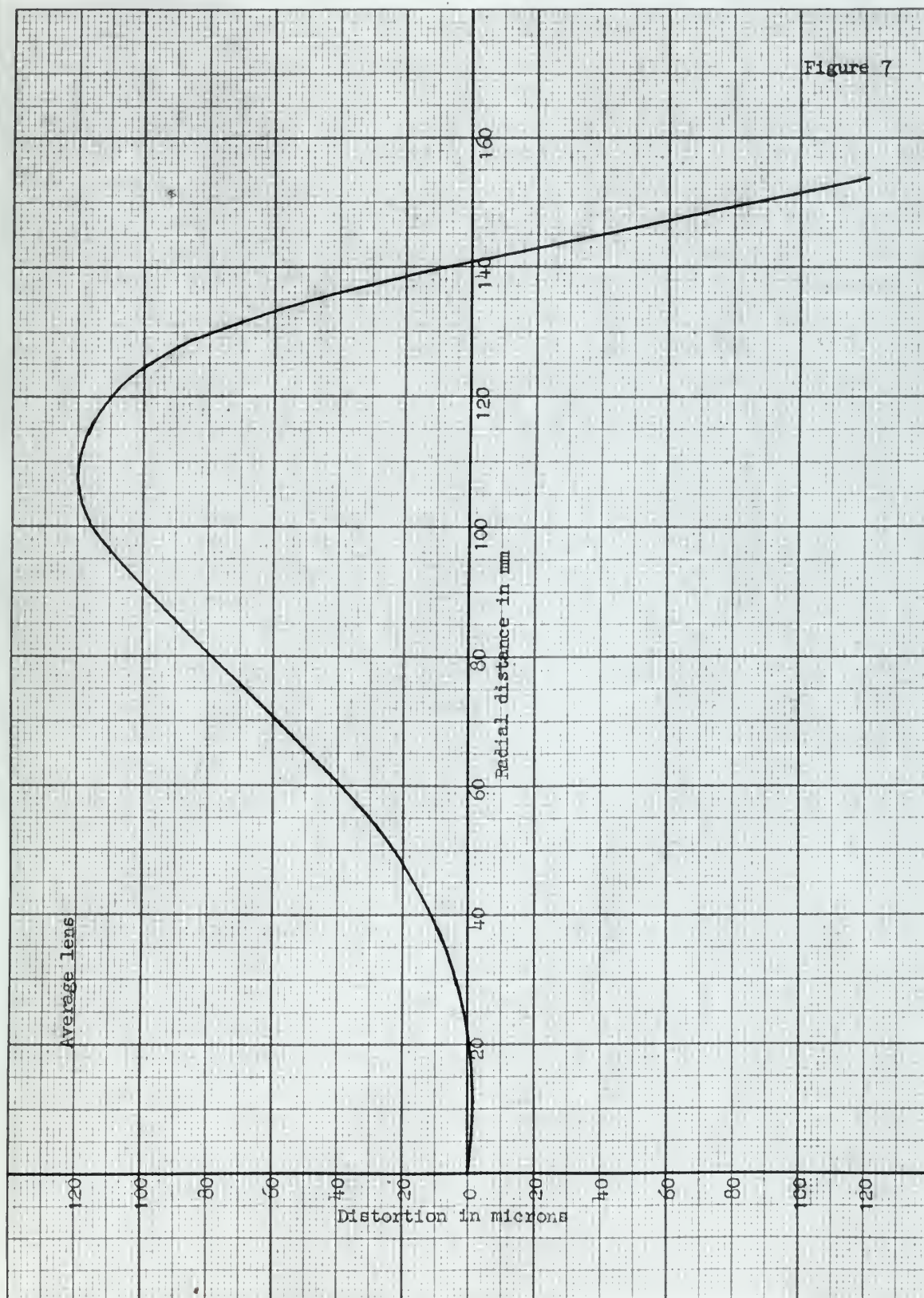
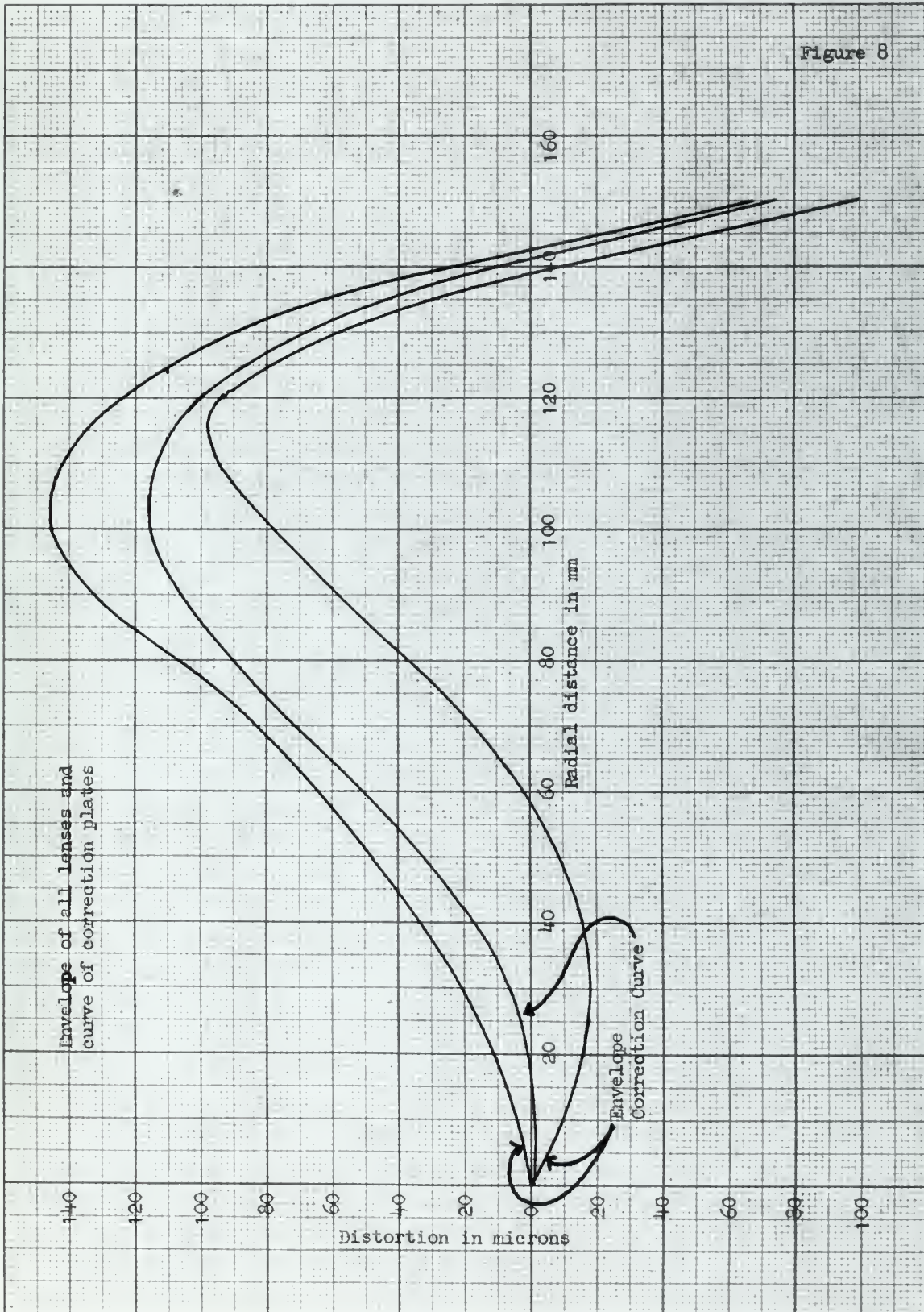
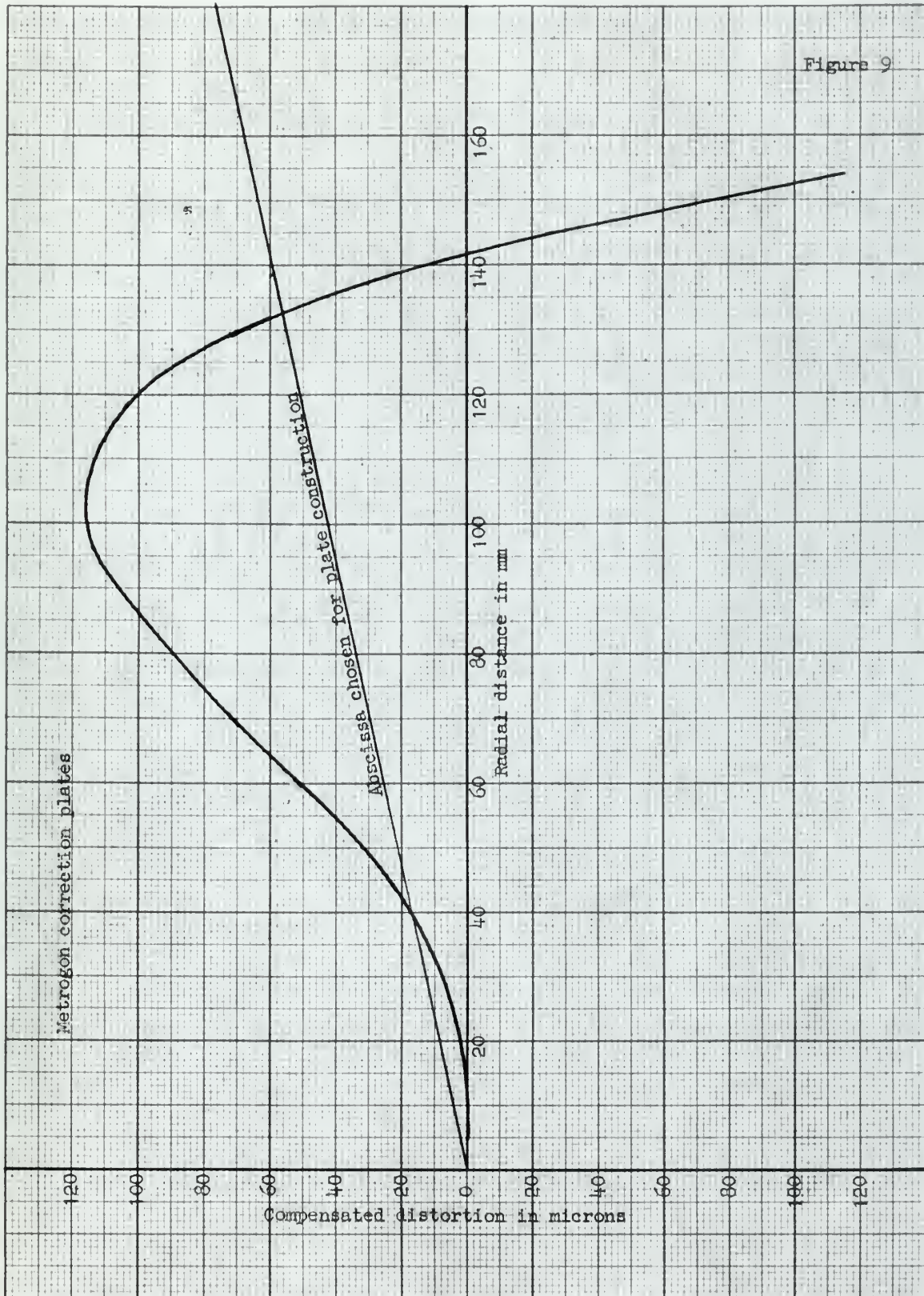


Figure 8





VERIFYING THE CURVE OF THE NITROGEN CORRECTION PLATES

The nitrogen correction plates, serials 49 and 50, which were manufactured for The Ohio State University by Wild Instruments were used with grid test plates 377 and 378 to determine the actual displacement caused by the correction plates. These observations were made in the Wild A7 Autograph, using monocular vision and observing each grid plate through each correction plate. The instrument adjustments were all zeroed except focal length, set at 125 mm, and z, set at 300 mm. The measurements are contained in Tables VIII through XI. The numbering system used is consistent for all measurements. The first number refers to rows parallel to the X axis, starting on the Y positive (upper) side of the plate. The second number refers to rows parallel to the Y axis, starting at the X negative (left) side of the plate. The average distance of the projection of each grid intersection from the center is tabulated in Tables XII through XV.

These measurements were then compared with the true positions of the grid intersections. The distortions were then graphically converted to radial and tangential distortion and tabulated in Tables XVI through XIX. Then the distortion figures were reduced to photo scale, averaged for each correction plate and tabulated in Tables XX and XXI. The sign conventions used in Table XVI and subsequently are positive away from center in the case of radial, and

positive clockwise when viewed from above in the case of tangential distortion.

As is obvious from the tangential distortion figures, there is apparently some θ rotation error in the alignment of the grid plates in the autograph. In order to eliminate any effect of this error, the summation of the tangential distortions divided by the radial distance from center was set equal to zero and corrections applied accordingly. The results of these computations appear in Tables XXII and XXIII. Plots of these values do not indicate any systematic error except that the lower left half (as viewed from the top) is predominately negative and the upper right half is predominately positive. The magnitudes of distortion within these areas are completely random. The positive and negative patterns being similar indicates a systematic error either in the autograph optics or in the manufacture of the correction plates. There is not sufficient information or specialized equipment available to this writer to determine which source caused the error.

The radial distortions contained in Tables XX and XXI are plotted in relation to the curve provided Wild for the manufacture of the correction plates in Figures 10 and 11. As can be seen, the same range of random errors is present in radial distortion as is present in tangential distortion. However, the radial figures indicate a displacement toward the lower right of approximately the same magnitude as is evidenced by the tangential distortion.

If the above displacement were compensated, the tangential distortion figures would show no definite pattern and the radial

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distortion would approximate, within ± 10 microns, the curve provided for the construction of the plates. The errors resulting can be disregarded in any computation, without resulting in any appreciable error.

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Attribution to the environment, which occurred in the opposite

TABLE VIII

GRID 377 PLATE 49, GRID INTERSECTION COORDINATES

Point	X	Y	Point	X	Y
1-1	5627.53	1071.21	2-1	5627.42	1023.10
	53	22		42	11
	52	22		42	10
	53	21		42	10
2	5579.43	1071.09	2	5579.39	1023.03
	44	09		39	03
	44	10		39	03
	43	11		39	03
3	5531.41	1071.02	3	5531.39	1023.00
	40	02		39	01
	40	01		39	00
	41	03		39	01
4	5483.41	1070.99	4	5483.43	1023.00
	41	98		43	00
	41	99		43	01
	42	00		43	22.99
5	5435.46	1070.99	5	5435.49	1023.01
	46	99		50	01
	45	98		49	01
	46	98		49	01
6	5387.50	1070.98	6	5387.52	1023.03
	49	99		52	03
	49	99		52	03
	50	99		52	03
7	5339.54	1070.99	7	5339.55	1023.03
	54	99		55	03
	53	99		55	03
	53	98		55	02
8	5291.57	1071.01	8	5291.60	1023.02
	57	01		60	03
	57	70.99		60	02
	57	99		59	01
9	5243.58	1071.03	9	5243.63	1023.02
	59	04		64	02
	59	03		64	02
	60	03		63	02
10	5195.55	1071.11	10	5195.65	1023.07
	56	12		64	07
	57	11		64	06
	56	11		64	06
11	5147.42	1071.24	11	5147.56	1023.14
	42	23		57	13
	42	25		56	13
	42	25		56	13

TABLE VIII—Continued

Point	X	Y	Point	X	Y
3-1	5627.37	975.09	4-1	5627.34	927.09
	36	09		33	09
	37	10		33	09
	36	09		33	09
2	5579.36	975.05	2	5579.36	927.06
	36	05		35	07
	36	05		35	07
	36	04		35	07
3	5531.40	975.05	3	5531.43	927.08
	40	05		43	09
	40	05		43	09
	40	05		43	09
4	5483.47	975.08	4	5483.49	927.12
	47	08		49	12
	46	08		49	13
	47	08		49	12
5	5435.50	975.10	5	5435.51	927.13
	50	10		52	13
	49	10		52	13
	49	10		52	14
6	5387.53	975.12	6	5387.52	927.15
	53	12		52	15
	53	12		51	15
	52	12		51	15
7	5339.54	975.12	7	5339.52	927.16
	54	12		52	16
	54	12		51	16
	54	12		51	16
8	5291.59	975.09	8	5291.55	927.13
	58	09		54	13
	58	08		54	13
	58	08		54	14
9	5243.63	975.06	9	5243.60	927.10
	63	07		59	11
	63	06		59	11
	63	06		60	10
10	5195.68	975.06	10	5195.67	927.09
	68	06		67	10
	68	06		67	09
	67	05		66	09
11	5147.64	975.09	11	5147.67	927.08
	64	10		67	09
	65	10		67	09
	64	10		66	08

TABLE VIII--Continued

Point	X	Y	Point	X	Y
5-1	5627.34	879.12	6-1	5627.32	831.15
	34	13		32	16
	34	13		32	16
	34	12		31	16
2	5579.40	879.11	2	5579.38	831.15
	39	12		38	16
	39	12		38	16
	39	11		38	15
3	5531.47	879.13	3	5531.47	831.15
	47	13		46	16
	47	13		47	16
	47	13		47	16
4	5483.53	879.15	4	5483.53	831.16
	53	16		53	17
	53	16		54	17
	53	15		54	17
5	5435.55	879.16	5	5435.56	831.16
	56	17		56	17
	56	17		56	16
	55	17		57	16
6	5387.53	879.19	6	5387.53	831.19
	53	20		53	19
	52	20		53	18
	53	20		53	18
7	5339.51	879.19	7	5339.49	831.20
	51	19		49	20
	50	18		49	19
	50	19		49	20
8	5291.54	879.16	8	5291.52	831.17
	53	16		52	17
	53	16		52	18
	53	15		53	17
9	5243.59	879.14	9	5243.58	831.18
	59	14		58	18
	59	15		57	18
	59	14		57	18
10	5195.67	879.13	10	5195.67	831.19
	67	13		66	19
	67	14		66	19
	67	13		66	19
11	5147.70	879.12	11	5147.70	831.18
	70	13		70	17
	70	13		69	17
	70	13		70	18

TABLE VIII--Continued

Point	X	Y	Point	X	Y
7-1	5627.33	783.19	8-1	5627.35	735.22
	33	20		34	23
	32	20		34	24
	33	19		35	23
2	5579.37	783.18	2	5579.36	735.23
	37	18		36	23
	37	18		36	23
	37	18		36	23
3	5531.45	783.17	3	5531.43	735.21
	45	17		43	21
	46	17		44	21
	46	17		43	21
4	5483.51	783.16	4	5483.49	735.19
	50	16		49	19
	51	16		49	19
	51	16		50	19
5	5435.54	783.13	5	5435.52	735.15
	54	13		52	15
	54	13		53	15
	55	14		53	15
6	5387.53	783.13	6	5387.51	735.15
	53	13		51	16
	53	13		51	16
	52	13		52	16
7	5339.50	783.15	7	5339.51	735.18
	49	16		51	18
	50	16		51	18
	49	15		51	19
8	5291.51	783.14	8	5291.54	735.19
	51	15		54	19
	51	14		54	19
	51	15		55	19
9	5243.57	783.17	9	5243.60	735.23
	57	17		60	23
	57	17		59	23
	57	17		60	22
10	5195.65	783.18	10	5195.66	735.24
	64	19		67	25
	65	20		66	25
	65	19		66	25
11	5147.68	783.18	11	5147.66	735.22
	68	18		66	22
	68	19		66	23
	68	17		67	22

BANKRUPTCY COURT

Y	L	NAME	T	2	NAME
10-01	10-01	J-0	11-01	11-01	J-0
10-02	10-02	A	11-02	11-02	A
10-03	10-03	C	11-03	11-03	C
10-04	10-04	A	11-04	11-04	A
10-05	10-05	B	11-05	11-05	B
10-06	10-06	A	11-06	11-06	A
10-07	10-07	F	11-07	11-07	F
10-08	10-08	B	11-08	11-08	B
10-09	10-09	B	11-09	11-09	B
10-10	10-10	10	11-10	11-10	10
10-11	10-11	11	11-11	11-11	11

TABLE VIII—Continued

Point	X	Y	Point	X	Y
9-1	5627.37	687.25	10-1	5627.43	639.19
	36	25		42	20
	36	25		42	21
	36	25		42	20
2	5579.35	687.27	2	5579.40	639.27
	35	28		39	26
	35	28		40	27
	35	28		39	26
3	5531.40	687.28	3	5531.40	639.29
	41	28		40	30
	41	29		40	30
	40	28		40	29
4	5483.45	687.27	4	5483.43	639.31
	45	27		43	32
	46	28		44	32
	45	28		44	32
5	5435.50	687.24	5	5435.48	639.28
	50	23		48	28
	50	24		48	28
	50	24		48	28
6	5387.51	687.24	6	5387.50	639.29
	51	23		50	29
	51	24		50	29
	51	23		50	29
7	5339.53	687.26	7	5339.53	639.32
	53	26		53	31
	52	27		52	37
	53	26		52	36
8	5291.57	687.25	8	5291.57	639.29
	57	26		57	29
	57	26		57	30
	56	25		57	30
9	5243.62	687.27	9	5243.61	639.29
	61	28		60	29
	61	28		60	29
	61	28		60	29
10	5195.66	687.29	10	5195.63	639.26
	66	28		63	27
	66	28		63	27
	66	28		62	26
11	5147.63	687.23	11	5147.53	639.18
	64	23		53	18
	63	24		53	19
	63	23		53	17

TABLE VIII—Continued

Point	X	Y
11-1	5627.58	591.07
	57	08
	57	08
	56	08
2	5579.45	591.21
	45	22
	45	22
	45	21
3	5531.43	591.29
	41	30
	42	30
	41	31
4	5483.43	591.34
	43	34
	44	35
	43	34
5	5435.46	591.34
	47	34
	46	35
	47	34
6	5387.50	591.35
	49	36
	50	36
	49	35
7	5339.52	591.37
	52	37
	52	37
	52	36
8	5291.54	591.30
	55	31
	55	31
	54	31
9	5243.56	591.27
	55	29
	56	29
	55	29
10	5195.52	591.22
	52	22
	52	23
	52	22
11	5147.38	591.05
	38	06
	37	05
	38	06

TABLE 1—1950-1951

Y		Z		X	
1950		1951		1952	
1	1.00	1	1.00	1	1.00
2	1.00	2	1.00	2	1.00
3	1.00	3	1.00	3	1.00
4	1.00	4	1.00	4	1.00
5	1.00	5	1.00	5	1.00
6	1.00	6	1.00	6	1.00
7	1.00	7	1.00	7	1.00
8	1.00	8	1.00	8	1.00
9	1.00	9	1.00	9	1.00
10	1.00	10	1.00	10	1.00
11	1.00	11	1.00	11	1.00
12	1.00	12	1.00	12	1.00

TABLE IX

GRID 378 PLATE 49, GRID INTERSECTION COORDINATES

Point	X	Y	Point	X	Y
1-1	5029.59	1060.01	2-1	5029.48	1011.91
	59	02		48	92
	59	01		48	92
	60	01		48	91
2	4981.49	1059.91	2	4981.45	1011.84
	49	91		44	84
	49	90		45	85
	50	91		45	84
3	4933.46	1059.84	3	4933.46	1011.82
	45	84		45	82
	46	85		45	82
	46	84		46	83
4	4885.48	1059.79	4	4885.51	1011.81
	47	81		50	82
	47	80		50	82
	47	81		50	81
5	4837.52	1059.79	5	4837.56	1011.82
	52	79		55	82
	51	79		55	83
	51	80		55	82
6	4789.56	1059.79	6	4789.59	1011.85
	57	80		58	84
	56	80		58	84
	56	79		58	84
7	4741.61	1059.80	7	4741.61	1011.85
	61	81		62	84
	60	81		62	85
	60	80		61	85
8	4693.63	1059.81	8	4693.66	1011.83
	64	83		66	83
	63	82		65	84
	63	82		65	83
9	4645.65	1059.84	9	4645.70	1011.84
	65	85		70	84
	66	86		70	85
	65	86		69	85
10	4597.61	1059.94	10	4597.71	1011.88
	61	95		70	89
	61	95		70	89
	61	94		70	88
11	4549.48	1060.07	11	4549.62	1011.95
	49	06		61	95
	48	06		62	95
	48	06		61	95

TABLE 22

GROSS DOMESTIC PRODUCT (GDP) IN CURRENT PRICES

Year	1	2	3	4	5
1950	100.0	100.0	100.0	100.0	100.0
1951	101.5	101.5	101.5	101.5	101.5
1952	103.0	103.0	103.0	103.0	103.0
1953	104.5	104.5	104.5	104.5	104.5
1954	106.0	106.0	106.0	106.0	106.0
1955	107.5	107.5	107.5	107.5	107.5
1956	109.0	109.0	109.0	109.0	109.0
1957	110.5	110.5	110.5	110.5	110.5
1958	112.0	112.0	112.0	112.0	112.0
1959	113.5	113.5	113.5	113.5	113.5
1960	115.0	115.0	115.0	115.0	115.0
1961	116.5	116.5	116.5	116.5	116.5
1962	118.0	118.0	118.0	118.0	118.0
1963	119.5	119.5	119.5	119.5	119.5
1964	121.0	121.0	121.0	121.0	121.0
1965	122.5	122.5	122.5	122.5	122.5
1966	124.0	124.0	124.0	124.0	124.0
1967	125.5	125.5	125.5	125.5	125.5
1968	127.0	127.0	127.0	127.0	127.0
1969	128.5	128.5	128.5	128.5	128.5
1970	130.0	130.0	130.0	130.0	130.0
1971	131.5	131.5	131.5	131.5	131.5
1972	133.0	133.0	133.0	133.0	133.0
1973	134.5	134.5	134.5	134.5	134.5
1974	136.0	136.0	136.0	136.0	136.0
1975	137.5	137.5	137.5	137.5	137.5
1976	139.0	139.0	139.0	139.0	139.0
1977	140.5	140.5	140.5	140.5	140.5
1978	142.0	142.0	142.0	142.0	142.0
1979	143.5	143.5	143.5	143.5	143.5
1980	145.0	145.0	145.0	145.0	145.0
1981	146.5	146.5	146.5	146.5	146.5
1982	148.0	148.0	148.0	148.0	148.0
1983	149.5	149.5	149.5	149.5	149.5
1984	151.0	151.0	151.0	151.0	151.0
1985	152.5	152.5	152.5	152.5	152.5
1986	154.0	154.0	154.0	154.0	154.0
1987	155.5	155.5	155.5	155.5	155.5
1988	157.0	157.0	157.0	157.0	157.0
1989	158.5	158.5	158.5	158.5	158.5
1990	160.0	160.0	160.0	160.0	160.0
1991	161.5	161.5	161.5	161.5	161.5
1992	163.0	163.0	163.0	163.0	163.0
1993	164.5	164.5	164.5	164.5	164.5
1994	166.0	166.0	166.0	166.0	166.0
1995	167.5	167.5	167.5	167.5	167.5
1996	169.0	169.0	169.0	169.0	169.0
1997	170.5	170.5	170.5	170.5	170.5
1998	172.0	172.0	172.0	172.0	172.0
1999	173.5	173.5	173.5	173.5	173.5
2000	175.0	175.0	175.0	175.0	175.0
2001	176.5	176.5	176.5	176.5	176.5
2002	178.0	178.0	178.0	178.0	178.0
2003	179.5	179.5	179.5	179.5	179.5
2004	181.0	181.0	181.0	181.0	181.0
2005	182.5	182.5	182.5	182.5	182.5
2006	184.0	184.0	184.0	184.0	184.0
2007	185.5	185.5	185.5	185.5	185.5
2008	187.0	187.0	187.0	187.0	187.0
2009	188.5	188.5	188.5	188.5	188.5
2010	190.0	190.0	190.0	190.0	190.0
2011	191.5	191.5	191.5	191.5	191.5
2012	193.0	193.0	193.0	193.0	193.0
2013	194.5	194.5	194.5	194.5	194.5
2014	196.0	196.0	196.0	196.0	196.0
2015	197.5	197.5	197.5	197.5	197.5
2016	199.0	199.0	199.0	199.0	199.0
2017	200.5	200.5	200.5	200.5	200.5
2018	202.0	202.0	202.0	202.0	202.0
2019	203.5	203.5	203.5	203.5	203.5
2020	205.0	205.0	205.0	205.0	205.0
2021	206.5	206.5	206.5	206.5	206.5
2022	208.0	208.0	208.0	208.0	208.0
2023	209.5	209.5	209.5	209.5	209.5
2024	211.0	211.0	211.0	211.0	211.0
2025	212.5	212.5	212.5	212.5	212.5
2026	214.0	214.0	214.0	214.0	214.0
2027	215.5	215.5	215.5	215.5	215.5
2028	217.0	217.0	217.0	217.0	217.0
2029	218.5	218.5	218.5	218.5	218.5
2030	220.0	220.0	220.0	220.0	220.0

TABLE IX—Continued

Point	X	Y	Point	X	Y
3-1	5029.43	963.90	4-1	5029.40	915.89
	43	91		39	90
	42	91		39	90
	42	90		40	89
2	4981.42	963.86	2	4981.41	915.87
	42	87		40	88
	41	86		40	89
	42	86		41	88
3	4933.46	963.86	3	4933.46	915.90
	46	85		48	91
	46	85		47	90
	46	86		47	91
4	4885.52	963.89	4	4885.54	915.93
	52	90		55	93
	51	90		54	94
	52	90		54	94
5	4837.56	963.91	5	4837.58	915.95
	56	91		59	94
	55	92		57	94
	55	92		57	95
6	4789.59	963.92	6	4789.58	915.97
	59	93		58	97
	58	92		58	97
	58	92		58	97
7	4741.61	963.93	7	4741.57	915.97
	60	93		58	98
	60	93		57	97
	60	93		57	98
8	4693.64	963.90	8	4693.61	915.94
	63	91		60	95
	63	91		60	95
	63	90		60	94
9	4645.69	963.88	9	4645.66	915.93
	70	89		66	93
	69	88		66	93
	69	89		66	92
10	4597.74	963.89	10	4597.73	915.91
	74	90		73	92
	74	90		73	91
	74	89		72	91
11	4549.70	963.94	11	4549.73	915.92
	71	95		73	92
	70	95		73	93
	71	94		73	92

Y	A	Value	Z	Q	Value
0.00	0.0000	0.00	0.00	0.0000	0.00
0.01	0.0040	1	0.01	0.0040	1
0.02	0.0080	2	0.02	0.0080	2
0.03	0.0120	3	0.03	0.0120	3
0.04	0.0160	4	0.04	0.0160	4
0.05	0.0200	5	0.05	0.0200	5
0.06	0.0240	6	0.06	0.0240	6
0.07	0.0280	7	0.07	0.0280	7
0.08	0.0320	8	0.08	0.0320	8
0.09	0.0360	9	0.09	0.0360	9
0.10	0.0400	10	0.10	0.0400	10
0.11	0.0440	11	0.11	0.0440	11
0.12	0.0480	12	0.12	0.0480	12
0.13	0.0520	13	0.13	0.0520	13
0.14	0.0560	14	0.14	0.0560	14
0.15	0.0600	15	0.15	0.0600	15
0.16	0.0640	16	0.16	0.0640	16
0.17	0.0680	17	0.17	0.0680	17
0.18	0.0720	18	0.18	0.0720	18
0.19	0.0760	19	0.19	0.0760	19
0.20	0.0800	20	0.20	0.0800	20
0.21	0.0840	21	0.21	0.0840	21
0.22	0.0880	22	0.22	0.0880	22
0.23	0.0920	23	0.23	0.0920	23
0.24	0.0960	24	0.24	0.0960	24
0.25	0.1000	25	0.25	0.1000	25
0.26	0.1040	26	0.26	0.1040	26
0.27	0.1080	27	0.27	0.1080	27
0.28	0.1120	28	0.28	0.1120	28
0.29	0.1160	29	0.29	0.1160	29
0.30	0.1200	30	0.30	0.1200	30
0.31	0.1240	31	0.31	0.1240	31
0.32	0.1280	32	0.32	0.1280	32
0.33	0.1320	33	0.33	0.1320	33
0.34	0.1360	34	0.34	0.1360	34
0.35	0.1400	35	0.35	0.1400	35
0.36	0.1440	36	0.36	0.1440	36
0.37	0.1480	37	0.37	0.1480	37
0.38	0.1520	38	0.38	0.1520	38
0.39	0.1560	39	0.39	0.1560	39
0.40	0.1600	40	0.40	0.1600	40
0.41	0.1640	41	0.41	0.1640	41
0.42	0.1680	42	0.42	0.1680	42
0.43	0.1720	43	0.43	0.1720	43
0.44	0.1760	44	0.44	0.1760	44
0.45	0.1800	45	0.45	0.1800	45
0.46	0.1840	46	0.46	0.1840	46
0.47	0.1880	47	0.47	0.1880	47
0.48	0.1920	48	0.48	0.1920	48
0.49	0.1960	49	0.49	0.1960	49
0.50	0.2000	50	0.50	0.2000	50

TABLE IX—Continued

Point	X	Y	Point	X	Y
5-1	5029.39	867.93	6-1	5029.37	819.97
	39	94		36	97
	38	94		36	98
	38	94		37	98
2	4981.44	867.93	2	4981.43	819.96
	44	93		43	97
	44	93		43	97
	44	93		42	97
3	4933.51	867.94	3	4933.52	819.97
	52	94		51	98
	51	94		51	98
	52	94		51	98
4	4885.59	867.96	4	4885.58	819.98
	58	96		58	97
	58	97		58	98
	58	97		58	98
5	4837.61	867.98	5	4837.62	819.97
	61	98		61	97
	61	98		62	98
	60	98		62	97
6	4789.60	868.01	6	4789.58	820.00
	59	01		58	00
	58	01		58	00
	59	01		58	00
7	4741.57	868.01	7	4741.55	820.01
	57	01		54	01
	57	02		54	01
	57	01		55	01
8	4693.59	867.97	8	4693.57	819.98
	58	97		57	99
	58	98		56	98
	58	97		56	98
9	4645.65	867.96	9	4645.64	820.01
	65	96		64	01
	64	97		63	00
	64	96		63	00
10	4597.73	867.96	10	4597.72	820.00
	72	96		71	02
	73	96		71	01
	72	95		71	01
11	4549.76	867.96	11	4549.75	820.00
	75	96		75	00
	75	96		74	00
	75	95		75	00

구분	구분	구분	구분	구분	구분
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
49	50	51	52	53	54
55	56	57	58	59	60
61	62	63	64	65	66
67	68	69	70	71	72
73	74	75	76	77	78
79	80	81	82	83	84
85	86	87	88	89	90
91	92	93	94	95	96
97	98	99	100	101	102
103	104	105	106	107	108
109	110	111	112	113	114
115	116	117	118	119	120
121	122	123	124	125	126
127	128	129	130	131	132
133	134	135	136	137	138
139	140	141	142	143	144
145	146	147	148	149	150
151	152	153	154	155	156
157	158	159	160	161	162
163	164	165	166	167	168
169	170	171	172	173	174
175	176	177	178	179	180
181	182	183	184	185	186
187	188	189	190	191	192
193	194	195	196	197	198
199	200	201	202	203	204
205	206	207	208	209	210
211	212	213	214	215	216
217	218	219	220	221	222
223	224	225	226	227	228
229	230	231	232	233	234
235	236	237	238	239	240
241	242	243	244	245	246
247	248	249	250	251	252
253	254	255	256	257	258
259	260	261	262	263	264
265	266	267	268	269	270
271	272	273	274	275	276
277	278	279	280	281	282
283	284	285	286	287	288
289	290	291	292	293	294
295	296	297	298	299	300
301	302	303	304	305	306
307	308	309	310	311	312
313	314	315	316	317	318
319	320	321	322	323	324
325	326	327	328	329	330
331	332	333	334	335	336
337	338	339	340	341	342
343	344	345	346	347	348
349	350	351	352	353	354
355	356	357	358	359	360
361	362	363	364	365	366
367	368	369	370	371	372
373	374	375	376	377	378
379	380	381	382	383	384
385	386	387	388	389	390
391	392	393	394	395	396
397	398	399	400	401	402
403	404	405	406	407	

TABLE IX--Continued

Point	X	Y	Point	X	Y
7-1	5029.37	772.00	8-1	5029.39	724.04
	37	01		39	04
	37	01		39	05
	36	00		39	05
2	4981.41	771.99	2	4981.40	724.04
	41	99		41	05
	41	72.00		40	05
	41	99		41	05
3	4933.50	771.98	3	4933.48	724.03
	50	98		48	03
	50	98		48	03
	50	97		48	03
4	4885.56	771.97	4	4885.54	724.00
	56	97		54	01
	56	97		54	01
	56	98		54	01
5	4837.59	771.95	5	4837.57	723.97
	59	95		56	97
	59	95		57	97
	59	94		56	97
6	4789.58	771.96	6	4789.56	723.97
	57	95		56	98
	56	95		56	97
	57	96		56	97
7	4741.55	771.96	7	4741.56	724.00
	55	96		57	00
	54	97		57	00
	54	96		57	00
8	4693.56	771.95	8	4693.59	724.01
	55	96		59	01
	56	96		59	01
	56	96		60	01
9	4645.62	771.98	9	4645.65	724.06
	61	99		64	05
	61	99		64	05
	61	99		65	05
10	4597.69	772.01	10	4597.71	724.08
	69	02		71	08
	70	01		71	08
	69	01		71	07
11	4549.73	772.00	11	4549.71	724.06
	73	01		72	07
	72	01		71	05
	73	00		72	05

TABLE IX--Continued

Point	X	Y	Point	X	Y
9-1	5029.40	676.08	10-1	5029.48	628.02
	41	08		48	01
	40	08		47	03
	40	08		47	03
2	4981.41	676.10	2	4981.44	628.08
	40	10		44	08
	40	10		43	09
	40	10		43	09
3	4933.45	676.09	3	4933.45	628.11
	46	08		45	11
	46	09		45	11
	45	09		44	11
4	4885.50	676.09	4	4885.48	628.13
	50	09		48	13
	50	09		48	13
	50	09		48	12
5	4837.54	676.05	5	4837.53	628.10
	55	05		53	10
	54	05		53	10
	54	06		53	10
6	4789.56	676.05	6	4789.55	628.10
	56	06		56	10
	55	06		56	10
	56	06		55	10
7	4741.58	676.07	7	4741.58	628.12
	58	07		58	13
	57	08		58	13
	57	07		58	13
8	4693.61	676.07	8	4693.62	628.11
	61	07		61	11
	61	07		61	11
	61	07		62	11
9	4645.67	676.09	9	4645.66	628.11
	67	09		65	11
	67	09		65	11
	67	09		65	12
10	4597.71	676.10	10	4597.66	628.11
	70	12		67	10
	70	11		67	10
	70	11		66	10
11	4549.69	676.06	11	4549.58	628.01
	68	07		57	00
	68	07		57	01
	69	07		57	01

[illegible]

TABLE IX--Continued

Point	X	T
11-1	5029.62	579.89
	63	90
	62	90
	61	89
2	4981.49	580.04
	50	04
	50	04
	49	03
3	4933.47	580.10
	47	10
	47	11
	47	10
4	4885.48	580.16
	48	15
	48	16
	48	16
5	4837.52	580.16
	51	16
	51	16
	50	16
6	4789.55	580.17
	55	17
	54	17
	54	18
7	4741.57	580.18
	57	18
	57	18
	56	18
8	4693.59	580.12
	59	13
	59	13
	59	13
9	4645.60	580.09
	61	10
	61	10
	60	09
10	4597.56	580.02
	56	02
	56	03
	56	03
11	4549.42	579.86
	43	85
	42	86
	43	85

TABLE 1000—2000

Y	X	d(x,y)	d(x,y)
100	100	0.00	0.00
100	101	0.01	0.01
100	102	0.02	0.02
100	103	0.03	0.03
100	104	0.04	0.04
100	105	0.05	0.05
100	106	0.06	0.06
100	107	0.07	0.07
100	108	0.08	0.08
100	109	0.09	0.09
100	110	0.10	0.10
100	111	0.11	0.11
100	112	0.12	0.12
100	113	0.13	0.13
100	114	0.14	0.14
100	115	0.15	0.15
100	116	0.16	0.16
100	117	0.17	0.17
100	118	0.18	0.18
100	119	0.19	0.19
100	120	0.20	0.20
100	121	0.21	0.21
100	122	0.22	0.22
100	123	0.23	0.23
100	124	0.24	0.24
100	125	0.25	0.25
100	126	0.26	0.26
100	127	0.27	0.27
100	128	0.28	0.28
100	129	0.29	0.29
100	130	0.30	0.30
100	131	0.31	0.31
100	132	0.32	0.32
100	133	0.33	0.33
100	134	0.34	0.34
100	135	0.35	0.35
100	136	0.36	0.36
100	137	0.37	0.37
100	138	0.38	0.38
100	139	0.39	0.39
100	140	0.40	0.40
100	141	0.41	0.41
100	142	0.42	0.42
100	143	0.43	0.43
100	144	0.44	0.44
100	145	0.45	0.45
100	146	0.46	0.46
100	147	0.47	0.47
100	148	0.48	0.48
100	149	0.49	0.49
100	150	0.50	0.50
100	151	0.51	0.51
100	152	0.52	0.52
100	153	0.53	0.53
100	154	0.54	0.54
100	155	0.55	0.55
100	156	0.56	0.56
100	157	0.57	0.57
100	158	0.58	0.58
100	159	0.59	0.59
100	160	0.60	0.60
100	161	0.61	0.61
100	162	0.62	0.62
100	163	0.63	0.63
100	164	0.64	0.64
100	165	0.65	0.65
100	166	0.66	0.66
100	167	0.67	0.67
100	168	0.68	0.68
100	169	0.69	0.69
100	170	0.70	0.70
100	171	0.71	0.71
100	172	0.72	0.72
100	173	0.73	0.73
100	174	0.74	0.74
100	175	0.75	0.75
100	176	0.76	0.76
100	177	0.77	0.77
100	178	0.78	0.78
100	179	0.79	0.79
100	180	0.80	0.80
100	181	0.81	0.81
100	182	0.82	0.82
100	183	0.83	0.83
100	184	0.84	0.84
100	185	0.85	0.85
100	186	0.86	0.86
100	187	0.87	0.87
100	188	0.88	0.88
100	189	0.89	0.89
100	190	0.90	0.90
100	191	0.91	0.91
100	192	0.92	0.92
100	193	0.93	0.93
100	194	0.94	0.94
100	195	0.95	0.95
100	196	0.96	0.96
100	197	0.97	0.97
100	198	0.98	0.98
100	199	0.99	0.99
100	200	1.00	1.00

TABLE X

GRID 377 PLATE 50, GRID INTERSECTION COORDINATES

Point	X	Y	Point	X	Y
1-1	231.93	240.06	2-1	231.85	191.95
	93	04		86	94
	94	04		84	94
	94	05		85	96
2	183.86	239.95	2	183.81	191.88
	86	94		81	89
	86	94		80	88
	86	95		81	88
3	135.84	239.86	3	135.82	191.86
	83	87		81	86
	84	87		82	86
	84	88		82	86
4	87.85	239.84	4	87.85	191.87
	84	83		86	87
	84	84		86	87
	84	84		86	87
5	39.89	239.82	5	39.90	191.87
	88	81		90	88
	90	82		89	87
	90	83		90	87
6	9991.94	239.83	6	9991.95	191.89
	93	83		95	89
	93	83		95	89
	94	83		95	89
7	9943.97	239.83	7	9943.98	191.88
	96	83		98	88
	97	83		98	88
	97	84		98	88
8	9896.01	239.85	8	9896.02	191.87
	01	85		02	86
	00	84		02	86
	01	85		02	86
9	9848.02	239.87	9	9848.06	191.86
	02	89		07	87
	01	88		06	86
	02	88		06	86
10	9799.99	239.95	10	9800.07	191.89
	99	95		06	89
	98	94		06	89
	98	95		06	90
11	9751.85	240.09	11	9751.98	191.95
	85	10		98	95
	84	09		98	95
	85	08		98	95

TABLE 1

MEAN AIR TEMPERATURE AND RELATIVE HUMIDITY

Month	1	2	3	4	5	6
1-1	10.2	10.2	10.2	10.2	10.2	10.2
2	10.2	10.2	10.2	10.2	10.2	10.2
3	10.2	10.2	10.2	10.2	10.2	10.2
4	10.2	10.2	10.2	10.2	10.2	10.2
5	10.2	10.2	10.2	10.2	10.2	10.2
6	10.2	10.2	10.2	10.2	10.2	10.2
7	10.2	10.2	10.2	10.2	10.2	10.2
8	10.2	10.2	10.2	10.2	10.2	10.2
9	10.2	10.2	10.2	10.2	10.2	10.2
10	10.2	10.2	10.2	10.2	10.2	10.2
11	10.2	10.2	10.2	10.2	10.2	10.2
12	10.2	10.2	10.2	10.2	10.2	10.2

TABLE X--Continued

Point	X	Y	Point	X	Y
3-1	231.79	143.93	4-1	231.75	95.94
	80	93		76	93
	79	93		76	93
	79	93		76	92
2	183.79	143.88	2	183.78	95.92
	79	88		78	92
	79	88		79	92
	79	88		79	92
3	135.83	143.89	3	135.85	95.95
	83	90		85	95
	83	89		85	95
	83	90		85	95
4	87.90	143.93	4	87.92	95.98
	90	93		92	98
	90	92		92	99
	90	93		92	98
5	39.93	143.94	5	39.95	96.00
	94	94		95	00
	93	94		94	00
	93	95		95	00
6	9991.95	143.96	6	9991.95	96.02
	96	96		95	02
	95	96		95	01
	95	96		95	01
7	9943.98	143.97	7	9943.96	96.01
	97	96		95	01
	98	96		94	01
	97	96		95	01
8	9896.01	143.94	8	9895.99	95.97
	01	93		98	97
	01	93		98	97
	01	94		98	96
9	9848.07	143.91	9	9848.04	95.96
	06	91		03	95
	06	91		03	96
	06	91		03	95
10	9800.11	143.90	10	9800.10	95.93
	11	90		09	93
	11	90		09	93
	10	90		10	92
11	9752.07	143.96	11	9752.11	95.93
	07	95		10	93
	07	95		11	93
	07	95		11	92

TABLE X--Continued

Point	X	Y	Point	X	Y
5-1	231.76	47.98	6-1	231.74	0.02
	76	97		74	02
	76	97		75	02
	76	96		75	02
2	183.81	47.97	2	183.81	0.01
	81	97		81	01
	81	96		81	01
	81	96		81	02
3	135.89	47.98	3	135.90	0.02
	89	98		90	02
	90	98		90	01
	89	98		90	01
4	87.97	48.02	4	87.97	0.03
	97	01		97	04
	97	01		97	03
	96	01		97	03
5	39.98	48.02	5	40.01	0.01
	98	02		01	01
	99	02		01	01
	98	02		00	01
6	9991.97	48.05	6	9991.97	0.02
	97	06		97	02
	96	05		97	03
	96	04		97	03
7	9943.93	48.05	7	9943.93	0.03
	93	04		93	03
	93	06		93	03
	93	05		92	03
8	9895.97	48.01	8	9895.95	0.02
	96	00		94	01
	97	01		95	02
	97	00		95	01
9	9848.03	47.98	9	9848.01	0.01
	02	99		01	01
	02	99		02	01
	01	98		01	01
10	9800.10	47.97	10	9800.07	0.01
	09	98		08	02
	10	98		08	01
	09	97		08	02
11	9752.13	47.96	11	9752.13	0.00
	12	97		12	00
	13	96		11	01
	13	96		12	01

Year	1990	1991	1992	1993	1994	1995
1990	100	100	100	100	100	100
1991	100	100	100	100	100	100
1992	100	100	100	100	100	100
1993	100	100	100	100	100	100
1994	100	100	100	100	100	100
1995	100	100	100	100	100	100

TABLE X--Continued

Point	X	Y	Point	X	Y
7-1	231.75	9952.03	8-1	231.78	9904.07
	76	04		78	08
	76	04		78	06
	76	04		78	08
2	183.79	9952.02	2	183.79	9904.09
	79	02		80	09
	79	02		80	09
	79	03		80	08
3	135.88	9952.01	3	135.88	9904.08
	87	02		87	07
	89	01		88	07
	88	01		88	07
4	87.94	9952.00	4	87.93	9904.06
	94	00		93	06
	95	00		93	05
	95	01		94	05
5	39.97	9951.99	5	39.97	9904.01
	96	98		96	01
	96	98		97	00
	97	98		97	01
6	9991.95	9951.99	6	9991.97	9904.01
	94	99		96	01
	94	99		97	00
	94	98		97	00
7	9943.90	9952.00	7	9943.95	9904.03
	91	00		96	04
	91	00		96	03
	91	00		95	03
8	9895.94	9952.00	8	9895.98	9904.02
	94	00		98	02
	93	00		99	03
	93	9951.99		98	02
9	9847.99	9952.02	9	9848.03	9904.06
	99	02		02	06
	9848.00	02		03	06
	00	02		02	06
10	9800.07	9952.03	10	9800.09	9904.07
	07	03		09	07
	07	03		09	06
	07	02		08	07
11	9752.10	9952.02	11	9752.10	9904.04
	09	02		08	05
	10	01		09	05
	09	01		08	06

TABLE 1

Year	1	2	3	4	5
1950	100	100	100	100	100
1951	100	100	100	100	100
1952	100	100	100	100	100
1953	100	100	100	100	100
1954	100	100	100	100	100
1955	100	100	100	100	100
1956	100	100	100	100	100
1957	100	100	100	100	100
1958	100	100	100	100	100
1959	100	100	100	100	100
1960	100	100	100	100	100
1961	100	100	100	100	100
1962	100	100	100	100	100
1963	100	100	100	100	100
1964	100	100	100	100	100
1965	100	100	100	100	100
1966	100	100	100	100	100
1967	100	100	100	100	100
1968	100	100	100	100	100
1969	100	100	100	100	100
1970	100	100	100	100	100
1971	100	100	100	100	100
1972	100	100	100	100	100
1973	100	100	100	100	100
1974	100	100	100	100	100
1975	100	100	100	100	100
1976	100	100	100	100	100
1977	100	100	100	100	100
1978	100	100	100	100	100
1979	100	100	100	100	100
1980	100	100	100	100	100
1981	100	100	100	100	100
1982	100	100	100	100	100
1983	100	100	100	100	100
1984	100	100	100	100	100
1985	100	100	100	100	100
1986	100	100	100	100	100
1987	100	100	100	100	100
1988	100	100	100	100	100
1989	100	100	100	100	100
1990	100	100	100	100	100
1991	100	100	100	100	100
1992	100	100	100	100	100
1993	100	100	100	100	100
1994	100	100	100	100	100
1995	100	100	100	100	100
1996	100	100	100	100	100
1997	100	100	100	100	100
1998	100	100	100	100	100
1999	100	100	100	100	100
2000	100	100	100	100	100
2001	100	100	100	100	100
2002	100	100	100	100	100
2003	100	100	100	100	100
2004	100	100	100	100	100
2005	100	100	100	100	100
2006	100	100	100	100	100
2007	100	100	100	100	100
2008	100	100	100	100	100
2009	100	100	100	100	100
2010	100	100	100	100	100
2011	100	100	100	100	100
2012	100	100	100	100	100
2013	100	100	100	100	100
2014	100	100	100	100	100
2015	100	100	100	100	100
2016	100	100	100	100	100
2017	100	100	100	100	100
2018	100	100	100	100	100
2019	100	100	100	100	100
2020	100	100	100	100	100

TABLE X—Continued

Point	X	Y	Point	X	Y
9-1	231.80	9856.09	10-1	231.86	9808.04
	80	09		87	05
	80	10		86	05
	80	09		86	04
2	183.79	9856.12	2	183.82	9808.11
	79	12		83	11
	80	12		83	11
	79	12		82	11
3	135.82	9856.13	3	135.83	9808.14
	83	12		83	13
	83	12		83	13
	83	13		83	12
4	87.88	9856.12	4	87.85	9808.16
	88	12		86	16
	89	12		86	16
	88	11		86	16
5	39.93	9856.08	5	39.90	9808.13
	92	07		90	12
	92	08		90	13
	93	07		90	12
6	9991.94	9856.08	6	9991.94	9808.13
	95	08		93	12
	94	08		93	13
	94	08		93	12
7	9943.95	9856.11	7	9943.96	9808.14
	94	11		96	14
	94	11		96	14
	94	11		96	14
8	9895.99	9856.09	8	9896.00	9808.12
	99	09		00	12
	99	10		9895.99	13
	98	10		99	12
9	9848.03	9856.13	9	9848.02	9808.11
	03	11		02	11
	03	12		02	12
	03	11		01	12
10	9800.08	9856.12	10	9800.01	9808.08
	08	12		02	09
	07	12		01	09
	07	12		02	08
11	9752.05	9856.07	11	9751.94	9808.00
	05	08		95	00
	06	07		96	00
	04	06		94	00

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

TABLE X—Continued

Point	X	Y
11-1	232.02	9759.93
	01	93
	01	94
	01	94
2	183.89	9760.07
	90	07
	90	07
	90	06
3	135.86	9760.11
	86	12
	86	12
	86	12
4	87.88	9760.19
	87	19
	88	20
	88	19
5	39.92	9760.17
	91	18
	92	19
	91	19
6	9991.94	9760.19
	94	19
	94	19
	94	19
7	9943.96	9760.19
	96	20
	96	20
	95	20
8	9895.99	9760.16
	98	15
	98	15
	98	15
9	9847.99	9760.11
	9848.00	12
	00	12
	00	11
10	9799.96	9760.06
	97	06
	97	05
	97	06
11	9751.81	9759.88
	82	87
	82	87
	81	87

Spectrophotometric method

S	A	Conc.	Conc.
0.000	0.128	0.00	0.00
0.000	0.134	0.00	0.00
0.000	0.137	0.00	0.00
0.000	0.141	0.00	0.00
0.000	0.145	0.00	0.00
0.000	0.149	0.00	0.00
0.000	0.153	0.00	0.00
0.000	0.157	0.00	0.00
0.000	0.161	0.00	0.00
0.000	0.165	0.00	0.00
0.000	0.169	0.00	0.00
0.000	0.173	0.00	0.00

TABLE XI

GRID 378 PLATE 50, GRID INTERSECTION COORDINATES

Point	X	Y	Point	X	Y
1-1	5673.43	1016.29	2-1	5673.33	968.21
	43	29		34	21
	43	29		33	21
	43	29		33	21
2	5625.35	1016.21	2	5625.28	968.15
	35	20		28	14
	34	20		28	14
	35	20		28	14
3	5577.32	1016.12	3	5577.30	968.14
	33	13		31	13
	32	13		31	13
	32	14		30	13
4	5529.34	1016.10	4	5529.35	968.15
	35	10		35	15
	34	10		34	15
	34	10		34	16
5	5481.39	1016.10	5	5481.39	968.16
	40	09		40	16
	38	09		39	16
	39	10		39	15
6	5433.43	1016.12	6	5433.44	968.18
	44	11		44	17
	43	11		45	18
	43	12		44	18
7	5385.47	1016.12	7	5385.47	968.17
	47	11		48	17
	46	12		48	17
	47	11		47	17
8	5337.52	1016.12	8	5337.51	968.16
	51	13		52	16
	51	13		51	15
	51	12		51	15
9	5289.53	1016.17	9	5289.56	968.16
	53	16		56	16
	53	16		56	15
	52	17		55	15
10	5241.50	1016.23	10	5241.56	968.19
	49	23		55	19
	49	23		55	18
	49	24		55	18
11	5193.36	1016.36	11	5193.48	968.25
	36	36		48	24
	36	37		48	24
	36	37		47	25

Table 2

Regression coefficients and standard errors for the model

Variable	1	2	3	4	5
Intercept	1.000	1.000	1.000	1.000	1.000
Age	0.001	0.001	0.001	0.001	0.001
Gender	0.001	0.001	0.001	0.001	0.001
Marital status	0.001	0.001	0.001	0.001	0.001
Education	0.001	0.001	0.001	0.001	0.001
Income	0.001	0.001	0.001	0.001	0.001
Health	0.001	0.001	0.001	0.001	0.001
Religion	0.001	0.001	0.001	0.001	0.001
Occupation	0.001	0.001	0.001	0.001	0.001
Region	0.001	0.001	0.001	0.001	0.001
Time	0.001	0.001	0.001	0.001	0.001
Error	0.001	0.001	0.001	0.001	0.001

TABLE XI--Continued

Point	X	Y	Point	X	Y
3-1	5673.26	920.19	4-1	5673.23	872.20
	26	19		23	20
	25	19		23	20
	25	19		22	20
2	5625.26	920.17	2	5625.25	872.21
	26	17		26	21
	25	16		25	20
	26	17		26	21
3	5577.30	920.18	3	5577.33	872.24
	31	18		33	23
	31	18		33	23
	31	18		33	23
4	5529.38	920.23	4	5529.39	872.29
	38	23		39	28
	37	22		40	28
	37	23		39	28
5	5481.42	920.24	5	5481.42	872.30
	41	24		43	30
	42	25		43	31
	41	24		42	31
6	5433.43	920.26	6	5433.43	872.33
	43	26		43	32
	43	26		44	33
	42	26		43	33
7	5385.46	920.26	7	5385.44	872.32
	46	27		43	32
	45	27		43	33
	46	27		43	33
8	5337.49	920.24	8	5337.45	972.28
	50	24		46	29
	50	24		46	28
	49	23		45	28
9	5289.55	920.21	9	5289.51	872.26
	55	21		51	26
	55	21		50	27
	55	21		51	26
10	5241.60	920.20	10	5241.58	872.24
	60	19		58	24
	59	20		58	24
	59	20		57	24
11	5193.56	920.24	11	5193.60	872.22
	57	23		59	23
	56	23		59	23
	57	23		59	23

TABLE KI--Continued

Point	X	Y	Point	X	Y
5-1	5673.23	824.24	6-1	5673.21	776.29
	23	24		22	28
	22	23		21	28
	22	24		22	28
2	5625.28	824.25	2	5625.28	776.29
	29	25		27	28
	28	25		28	29
	28	25		28	30
3	5577.37	824.27	3	5577.37	776.31
	37	27		38	30
	38	26		38	29
	37	27		37	31
4	5529.44	824.31	4	5529.44	776.32
	44	31		44	32
	45	31		44	32
	44	31		43	33
5	5481.46	824.33	5	5481.46	776.31
	46	32		47	31
	46	32		47	31
	46	33		47	31
6	5433.44	824.35	6	5433.46	776.32
	43	35		45	32
	44	35		45	32
	44	35		45	32
7	5385.42	824.36	7	5385.41	776.33
	42	36		40	34
	41	35		40	34
	41	36		40	33
8	5337.44	824.32	8	5337.41	776.32
	43	32		42	33
	43	32		42	32
	43	32		41	33
9	5289.50	824.30	9	5289.48	776.32
	50	30		46	33
	49	30		48	33
	49	30		48	33
10	5241.57	824.28	10	5241.56	776.33
	57	29		55	33
	57	28		56	32
	56	29		55	33
11	5193.59	824.26	11	5193.58	776.31
	59	25		59	31
	60	25		59	31
	59	26		59	31

TABLE 1.—Continued

State	1	2	3	4	5
26	1972	1973	1974	1975	1976
27	1977	1978	1979	1980	1981
28	1982	1983	1984	1985	1986
29	1987	1988	1989	1990	1991
30	1992	1993	1994	1995	1996
31	1997	1998	1999	2000	2001
32	2002	2003	2004	2005	2006
33	2007	2008	2009	2010	2011
34	2012	2013	2014	2015	2016
35	2017	2018	2019	2020	2021
36	2022	2023	2024	2025	2026
37	2027	2028	2029	2030	2031
38	2032	2033	2034	2035	2036
39	2037	2038	2039	2040	2041
40	2042	2043	2044	2045	2046
41	2047	2048	2049	2050	2051
42	2052	2053	2054	2055	2056
43	2057	2058	2059	2060	2061
44	2062	2063	2064	2065	2066
45	2067	2068	2069	2070	2071
46	2072	2073	2074	2075	2076
47	2077	2078	2079	2080	2081
48	2082	2083	2084	2085	2086
49	2087	2088	2089	2090	2091
50	2092	2093	2094	2095	2096
51	2097	2098	2099	2100	2101
52	2102	2103	2104	2105	2106
53	2107	2108	2109	2110	2111
54	2112	2113	2114	2115	2116
55	2117	2118	2119	2120	2121
56	2122	2123	2124	2125	2126
57	2127	2128	2129	2130	2131
58	2132	2133	2134	2135	2136
59	2137	2138	2139	2140	2141
60	2142	2143	2144	2145	2146
61	2147	2148	2149	2150	2151
62	2152	2153	2154	2155	2156
63	2157	2158	2159	2160	2161
64	2162	2163	2164	2165	2166
65	2167	2168	2169	2170	2171
66	2172	2173	2174	2175	2176
67	2177	2178	2179	2180	2181
68	2182	2183	2184	2185	2186
69	2187	2188	2189	2190	2191
70	2192	2193	2194	2195	2196
71	2197	2198	2199	2200	2201
72	2202	2203	2204	2205	2206
73	2207	2208	2209	2210	2211
74	2212	2213	2214	2215	2216
75	2217	2218	2219	2220	2221
76	2222	2223	2224	2225	2226
77	2227	2228	2229	2230	2231
78	2232	2233	2234	2235	2236
79	2237	2238	2239	2240	2241
80	2242	2243	2244	2245	2246
81	2247	2248	2249	2250	2251
82	2252	2253	2254	2255	2256
83	2257	2258	2259	2260	2261
84	2262	2263	2264	2265	2266
85	2267	2268	2269	2270	2271
86	2272	2273	2274	2275	2276
87	2277	2278	2279	2280	2281
88	2282	2283	2284	2285	2286
89	2287	2288	2289	2290	2291
90	2292	2293	2294	2295	2296
91	2297	2298	2299	2300	2301
92	2302	2303	2304	2305	2306
93	2307	2308	2309	2310	2311
94	2312	2313	2314	2315	2316
95	2317	2318	2319	2320	2321
96	2322	2323	2324	2325	2326
97	2327	2328	2329	2330	2331
98	2332	2333	2334	2335	2336
99	2337	2338	2339	2340	2341
100	2342	2343	2344	2345	2346

TABLE XI—Continued

Point	X	Y	Point	X	Y
7-1	5673.20	728.31	8-1	5673.23	680.35
	21	30		23	36
	21	31		22	35
	21	31		23	36
2	5625.24	728.31	2	5625.25	680.36
	25	30		25	36
	25	31		25	35
	25	31		25	37
3	5577.34	728.31	3	5577.32	680.36
	34	31		32	36
	34	31		32	35
	34	30		32	37
4	5529.40	728.30	4	5529.38	680.35
	40	30		39	35
	40	30		39	34
	40	30		39	35
5	5481.43	728.29	5	5481.42	680.32
	44	27		42	31
	45	28		42	31
	44	28		42	32
6	5433.41	728.29	6	5433.42	680.30
	41	28		42	30
	40	29		43	31
	41	28		42	31
7	5385.37	728.30	7	5385.42	680.34
	37	30		42	33
	37	30		42	34
	38	30		41	34
8	5337.40	728.31	8	5337.45	680.33
	40	31		44	32
	40	31		45	32
	39	31		44	33
9	5289.47	728.34	9	5289.50	680.36
	47	33		50	36
	47	33		49	36
	48	34		49	36
10	5241.53	728.35	10	5241.56	680.38
	54	34		56	38
	54	34		55	38
	54	35		55	38
11	5193.56	728.31	11	5193.56	680.36
	57	31		55	34
	57	32		56	35
	57	32		55	34

TABLE 1. 1957

Year	1	2	3	4	5
1957	100	100	100	100	100
1958	100	100	100	100	100
1959	100	100	100	100	100
1960	100	100	100	100	100
1961	100	100	100	100	100
1962	100	100	100	100	100
1963	100	100	100	100	100
1964	100	100	100	100	100
1965	100	100	100	100	100
1966	100	100	100	100	100
1967	100	100	100	100	100
1968	100	100	100	100	100
1969	100	100	100	100	100
1970	100	100	100	100	100
1971	100	100	100	100	100

TABLE XI—Continued

Point	X	Y	Point	X	Y
9-1	5673.25	632.36	10-1	5673.33	584.31
	26	35		33	30
	25	36		33	31
	26	36		33	31
2	5625.23	632.39	2	5625.28	584.37
	24	39		29	37
	23	39		28	37
	24	39		29	37
3	5577.28	632.40	3	5577.28	584.40
	28	41		29	40
	28	40		28	40
	29	41		28	41
4	5529.34	632.40	4	5529.32	584.43
	34	40		32	42
	34	40		32	43
	34	41		32	44
5	5481.39	632.37	5	5481.35	584.41
	38	36		36	41
	39	37		36	41
	38	37		36	42
6	5433.41	632.38	6	5433.38	584.41
	40	38		39	42
	40	38		39	42
	39	39		38	43
7	5385.42	632.40	7	5385.42	584.43
	42	39		42	43
	42	40		41	43
	41	40		42	44
8	5337.44	632.39	8	5337.46	584.41
	45	38		45	41
	45	38		45	41
	44	39		45	41
9	5289.50	632.41	9	5289.48	584.41
	50	41		48	40
	50	41		48	40
	50	41		48	41
10	5241.54	632.41	10	5241.47	584.37
	54	41		48	37
	54	41		48	37
	54	41		48	37
11	5193.51	632.34	11	5193.41	584.28
	51	34		41	28
	51	34		41	28
	51	34		42	27

TABLE XI—Continued

Point	X	Y
11-1	5673.46	536.19
	46	19
	45	20
	46	19
2	5625.36	536.32
	36	31
	35	32
	35	32
3	5577.34	536.39
	34	39
	34	39
	34	39
4	5529.34	536.43
	34	44
	35	44
	35	44
5	5481.37	536.45
	37	44
	37	45
	37	45
6	5433.40	536.47
	41	46
	40	47
	40	47
7	5385.43	536.48
	42	48
	42	48
	42	48
8	5337.45	536.43
	43	42
	45	43
	44	42
9	5289.46	536.39
	47	39
	46	39
	47	40
10	5241.43	536.32
	43	33
	43	33
	44	32
11	5193.27	536.17
	28	16
	28	16
	28	16

[illegible]

TABLE XII

GRID 377 PLATE 49, AVERAGE DISTANCES FROM CENTER IN MM AT
MODEL SCALE

Point	X	Y	Point	X	Y
1-1	-239.996	240.030	5-1	-239.810	47.940
2	-191.905	239.912	2	-191.862	47.930
3	-143.875	239.835	3	-143.940	47.945
4	-95.882	239.805	4	-96.000	47.970
5	-47.928	239.800	5	-48.015	47.982
6	0.035	239.802	6	0.002	48.012
7	47.995	239.802	7	48.025	48.002
8	95.960	239.815	8	95.998	47.972
9	143.940	239.848	9	143.940	47.958
10	191.970	239.928	10	191.860	47.948
11	240.110	240.058	11	239.830	47.942
2-1	-239.890	191.918	6-1	-239.788	- 0.028
2	-191.860	191.845	2	-191.850	- 0.030
3	-143.860	191.820	3	-143.938	- 0.028
4	-95.900	191.815	4	-96.005	- 0.018
5	-47.962	191.825	5	-48.032	- 0.012
6	0.010	191.845	6	0	0
7	47.980	191.842	7	48.040	0.012
8	95.932	191.835	8	96.008	- 0.002
9	143.895	191.835	9	143.955	- 0.005
10	191.888	191.880	10	191.868	0.005
11	239.968	191.948	11	239.832	- 0.010
3-1	-239.835	143.9075	7-1	-239.798	- 47.990
2	-191.830	143.862	2	-191.840	- 48.005
3	-143.870	143.865	3	-143.925	- 48.015
4	-95.938	143.895	4	-95.978	- 48.025
5	-47.965	143.915	5	-48.012	- 48.052
6	0.002	143.935	6	0.008	- 48.055
7	47.990	143.935	7	48.035	- 48.030
8	95.948	143.900	8	96.020	- 48.040
9	143.900	143.878	9	143.960	- 48.015
10	191.852	143.872	10	191.882	- 47.995
11	239.888	143.912	11	239.850	- 48.005
4-1	-239.802	95.905	8-1	-239.815	- 95.955
2	-191.822	95.882	2	-191.830	- 95.955
3	-143.900	95.902	3	-143.902	- 95.975
4	-95.960	95.940	4	-95.962	- 95.995
5	-47.988	95.948	5	-47.995	- 96.035
6	0.015	95.965	6	0.018	- 96.028
7	48.015	95.975	7	48.020	- 96.002
8	95.988	95.948	8	95.988	- 95.995
9	143.935	95.920	9	143.932	- 95.958
10	191.862	95.908	10	191.868	- 95.938
11	239.862	95.900	11	239.868	- 95.962

THE TABLE

THE TABLE SHOWS THE RESULTS OF THE ANALYSIS OF THE SAMPLES OF THE SUBSTANCE, AND THE PERCENTAGE OF THE DIFFERENT ELEMENTS.

ANALYSIS	PERCENTAGE	ANALYSIS	PERCENTAGE	ANALYSIS	PERCENTAGE	ANALYSIS	PERCENTAGE
1. Carbon	72.5	2. Hydrogen	12.5	3. Nitrogen	10.0	4. Oxygen	4.0
5. Sulfur	0.5	6. Phosphorus	0.5	7. Potassium	0.5	8. Calcium	0.5
9. Magnesium	0.5	10. Iron	0.5	11. Zinc	0.5	12. Copper	0.5
13. Lead	0.5	14. Silver	0.5	15. Gold	0.5	16. Platinum	0.5
17. Barium	0.5	18. Strontium	0.5	19. Rubidium	0.5	20. Cesium	0.5
21. Bismuth	0.5	22. Antimony	0.5	23. Arsenic	0.5	24. Tellurium	0.5
25. Selenium	0.5	26. Manganese	0.5	27. Chromium	0.5	28. Nickel	0.5
29. Cobalt	0.5	30. Vanadium	0.5	31. Niobium	0.5	32. Tantalum	0.5
33. Zirconium	0.5	34. Hafnium	0.5	35. Yttrium	0.5	36. Lanthanum	0.5
37. Cerium	0.5	38. Praseodymium	0.5	39. Neodymium	0.5	40. Promethium	0.5
41. Samarium	0.5	42. Europium	0.5	43. Gadolinium	0.5	44. Terbium	0.5
45. Dysprosium	0.5	46. Holmium	0.5	47. Erbium	0.5	48. Thulium	0.5
49. Ytterbium	0.5	50. Lutetium	0.5	51. Scandium	0.5	52. Titanium	0.5
53. Vanadium	0.5	54. Chromium	0.5	55. Manganese	0.5	56. Iron	0.5
57. Cobalt	0.5	58. Nickel	0.5	59. Copper	0.5	60. Zinc	0.5
61. Gallium	0.5	62. Germanium	0.5	63. Arsenic	0.5	64. Selenium	0.5
65. Tellurium	0.5	66. Iodine	0.5	67. Bromine	0.5	68. Chlorine	0.5
69. Fluorine	0.5	70. Oxygen	0.5	71. Nitrogen	0.5	72. Carbon	0.5
73. Hydrogen	0.5	74. Helium	0.5	75. Lithium	0.5	76. Beryllium	0.5
77. Boron	0.5	78. Carbon	0.5	79. Nitrogen	0.5	80. Oxygen	0.5
81. Fluorine	0.5	82. Neon	0.5	83. Sodium	0.5	84. Magnesium	0.5
85. Aluminum	0.5	86. Silicon	0.5	87. Phosphorus	0.5	88. Sulfur	0.5
89. Chlorine	0.5	90. Argon	0.5	91. Potassium	0.5	92. Calcium	0.5
93. Scandium	0.5	94. Titanium	0.5	95. Vanadium	0.5	96. Chromium	0.5
97. Manganese	0.5	98. Iron	0.5	99. Cobalt	0.5	100. Nickel	0.5

TABLE XII—Continued

Point	X	Y	Point	X	Y
9-1	-239.832	-143.935	11-1	-240.040	-240.108
2	-191.820	-143.908	2	-191.920	-239.970
3	-143.875	-143.902	3	-143.888	-239.885
4	- 95.922	-143.910	4	- 95.902	-239.842
5	- 47.970	-143.948	5	- 47.935	-239.842
6	0.020	-143.950	6	0.035	-239.830
7	48.002	-143.922	7	48.010	-239.818
8	95.962	-143.930	8	95.985	-239.878
9	143.918	-143.908	9	143.975	-239.900
10	191.870	-143.902	10	192.010	-239.962
11	239.898	-143.952	11	240.152	-240.130
10-1	-239.892	-191.985			
2	-191.865	-191.920			
3	-143.870	-191.890			
4	- 96.905	-191.872			
5	- 47.950	-191.905			
6	0.030	-191.895			
7	48.005	-191.870			
8	95.960	-191.890			
9	143.928	-191.895			
10	191.902	-191.920			
11	240.000	-192.005			

Table 1. Summary of the data

Year	1	2	3	4	5
1990	1000	1000	1000	1000	1000
1991	1000	1000	1000	1000	1000
1992	1000	1000	1000	1000	1000
1993	1000	1000	1000	1000	1000
1994	1000	1000	1000	1000	1000
1995	1000	1000	1000	1000	1000
1996	1000	1000	1000	1000	1000
1997	1000	1000	1000	1000	1000
1998	1000	1000	1000	1000	1000
1999	1000	1000	1000	1000	1000
2000	1000	1000	1000	1000	1000
2001	1000	1000	1000	1000	1000
2002	1000	1000	1000	1000	1000
2003	1000	1000	1000	1000	1000
2004	1000	1000	1000	1000	1000
2005	1000	1000	1000	1000	1000
2006	1000	1000	1000	1000	1000
2007	1000	1000	1000	1000	1000
2008	1000	1000	1000	1000	1000
2009	1000	1000	1000	1000	1000
2010	1000	1000	1000	1000	1000
2011	1000	1000	1000	1000	1000
2012	1000	1000	1000	1000	1000
2013	1000	1000	1000	1000	1000
2014	1000	1000	1000	1000	1000
2015	1000	1000	1000	1000	1000
2016	1000	1000	1000	1000	1000
2017	1000	1000	1000	1000	1000
2018	1000	1000	1000	1000	1000
2019	1000	1000	1000	1000	1000
2020	1000	1000	1000	1000	1000

TABLE XIII

GRID 378 PLATE 49, AVERAGE DISTANCES FROM CENTER IN MM AT
MODEL SCALE

Point	X	Y	Point	X	Y
1-1	-240.012	240.012	5-1	-239.805	47.938
2	-191.912	239.908	2	-191.860	47.930
3	-143.878	239.842	3	-143.935	47.940
4	-95.892	239.802	4	-96.002	47.965
5	-47.935	239.792	5	-48.028	47.980
6	0.018	239.795	6	-0.010	48.010
7	47.975	239.805	7	48.010	48.012
8	95.948	239.820	8	95.998	47.972
9	143.928	239.852	9	143.835	47.962
10	191.970	239.945	10	191.855	47.958
11	240.098	240.062	11	239.828	47.958
2-1	-239.900	191.915	6-1	-239.782	-0.025
2	-191.868	191.842	2	-191.848	-0.032
3	-143.875	191.822	3	-143.932	-0.022
4	-95.922	191.815	4	-96.000	-0.022
5	-47.972	191.822	5	-48.038	-0.028
6	-0.002	191.842	6	0	0
7	47.965	191.848	7	48.035	0.010
8	95.925	191.832	8	96.035	-0.018
9	143.882	191.845	9	143.945	0.005
10	191.878	191.885	10	191.868	0.010
11	239.965	191.950	11	239.832	0
3-1	-239.845	143.908	7-1	-239.782	-47.995
2	-191.838	143.862	2	-191.830	-48.008
3	-143.880	143.855	3	-143.920	-48.022
4	-95.938	143.898	4	-95.980	-48.028
5	-47.975	143.915	5	-48.010	-48.052
6	-0.005	143.922	6	0.010	-48.045
7	47.978	143.930	7	48.035	-48.038
8	95.948	143.905	8	96.022	-48.042
9	143.888	143.885	9	143.968	-48.012
10	191.840	143.895	10	191.892	-47.988
11	239.875	143.945	11	239.852	-47.995
4-1	-239.815	95.895	8-1	-239.810	-95.955
2	-191.825	95.880	2	-191.825	-95.952
3	-143.895	95.905	3	-143.900	-95.970
4	-95.962	95.935	4	-95.960	-95.992
5	-47.998	95.945	5	-47.985	-96.030
6	0	95.970	6	0.020	-96.038
7	48.008	95.975	7	48.012	-96.000
8	95.978	95.945	8	95.988	-95.990
9	143.920	95.928	9	143.935	-95.948
10	191.852	95.912	10	191.870	-95.922
11	239.850	95.922	11	239.862	-95.942

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Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

TABLE XIII--Continued

Point	X	Y	Point	X	Y
9-1	-239.822	-143.920	11-1	-240.040	-240.105
2	-191.822	-143.900	2	-191.915	-239.962
3	-143.875	-143.912	3	-143.890	-239.898
4	- 95.920	-143.910	4	- 95.900	-239.842
5	- 47.962	-143.948	5	- 47.930	-239.840
6	- 0.008	-143.942	6	0.035	-239.828
7	48.005	-143.928	7	48.012	-239.820
8	95.970	-143.930	8	95.990	-239.872
9	143.910	-143.910	9	143.975	-239.905
10	191.878	-143.890	10	192.020	-239.975
11	239.895	-143.938	11	240.155	-240.145
10-1	-239.895	-191.978			
2	-191.855	-191.915			
3	-143.868	-191.890			
4	- 95.900	-191.872			
5	- 47.950	-191.900			
6	0.025	-191.900			
7	48.000	-191.872			
8	95.965	-191.890			
9	143.928	-191.888			
10	191.915	-191.898			
11	240.008	-191.992			

[illegible]

TABLE XIV

GRID 377 PLATE 50, AVERAGE DISTANCES FROM CENTER IN MM AT
MODEL SCALE

Point	X	Y	Point	X	Y
1-1	-239.965	240.022	5-1	-239.990	47.950
2	-191.890	239.920	2	-191.840	47.940
3	-143.868	239.848	3	-143.922	47.955
4	-95.878	239.812	4	-95.998	47.988
5	-47.922	239.798	5	-48.012	48.045
6	0.035	239.805	6	0.005	48.025
7	48.002	239.858	7	48.040	48.025
8	95.962	239.822	8	96.002	47.980
9	143.952	239.905	9	143.950	47.960
10	191.985	239.972	10	191.885	47.950
11	240.122	240.065	11	239.852	47.938
2-1	-239.880	191.922	6-1	-239.775	- 0.005
2	-191.838	191.858	2	-191.840	- 0.012
3	-143.848	191.835	3	-143.930	- 0.010
4	-95.888	191.895	4	-96.000	- 0.008
5	-47.928	191.848	5	-48.038	- 0.015
6	0.020	191.868	6	0	0
7	47.990	191.855	7	48.042	0.005
8	95.950	191.838	8	96.022	- 0.010
9	143.908	191.838	9	143.958	- 0.015
10	191.908	191.868	10	191.892	- 0.010
11	239.990	191.925	11	239.850	- 0.020
3-1	-239.822	143.905	7-1	-239.788	- 47.988
2	-191.820	143.855	2	-191.820	- 47.952
3	-143.860	143.870	3	-143.910	- 48.012
4	-95.930	143.906	4	-95.975	- 48.022
5	-47.962	143.918	5	-47.995	- 48.042
6	0.018	143.935	6	0.028	- 48.038
7	47.995	143.988	7	48.072	- 48.025
8	95.960	143.910	8	96.035	- 48.032
9	143.908	143.885	9	143.975	- 48.005
10	191.862	143.875	10	191.900	- 47.998
11	239.900	143.978	11	239.875	- 48.010
4-1	-239.788	95.905	8-1	-239.810	- 95.948
2	-191.815	95.895	2	-191.828	- 95.938
3	-143.880	95.925	3	-143.908	- 95.948
4	-95.950	95.958	4	-95.962	- 95.970
5	-47.978	95.975	5	-47.998	- 96.018
6	0.020	95.990	6	0.002	- 96.020
7	48.020	95.985	7	48.015	- 95.992
8	95.988	95.942	8	95.988	- 96.002
9	143.938	95.930	9	143.945	- 95.965
10	191.875	95.902	10	191.882	- 95.952
11	239.862	95.902	11	239.882	- 95.975

2	4	18181	Y	2	18181
000.14	000.140	1-2	000.140	000.140	1-2
000.15	000.150	3	000.150	000.150	3
000.16	000.160	4	000.160	000.160	4
000.17	000.170	5	000.170	000.170	5
000.18	000.180	6	000.180	000.180	6
000.19	000.190	7	000.190	000.190	7
000.20	000.200	8	000.200	000.200	8
000.21	000.210	9	000.210	000.210	9
000.22	000.220	0	000.220	000.220	0
000.23	000.230	1	000.230	000.230	1
000.24	000.240	2	000.240	000.240	2
000.25	000.250	3	000.250	000.250	3
000.26	000.260	4	000.260	000.260	4
000.27	000.270	5	000.270	000.270	5
000.28	000.280	6	000.280	000.280	6
000.29	000.290	7	000.290	000.290	7
000.30	000.300	8	000.300	000.300	8
000.31	000.310	9	000.310	000.310	9
000.32	000.320	0	000.320	000.320	0
000.33	000.330	1	000.330	000.330	1
000.34	000.340	2	000.340	000.340	2
000.35	000.350	3	000.350	000.350	3
000.36	000.360	4	000.360	000.360	4
000.37	000.370	5	000.370	000.370	5
000.38	000.380	6	000.380	000.380	6
000.39	000.390	7	000.390	000.390	7
000.40	000.400	8	000.400	000.400	8
000.41	000.410	9	000.410	000.410	9
000.42	000.420	0	000.420	000.420	0
000.43	000.430	1	000.430	000.430	1
000.44	000.440	2	000.440	000.440	2
000.45	000.450	3	000.450	000.450	3
000.46	000.460	4	000.460	000.460	4
000.47	000.470	5	000.470	000.470	5
000.48	000.480	6	000.480	000.480	6
000.49	000.490	7	000.490	000.490	7
000.50	000.500	8	000.500	000.500	8
000.51	000.510	9	000.510	000.510	9
000.52	000.520	0	000.520	000.520	0
000.53	000.530	1	000.530	000.530	1
000.54	000.540	2	000.540	000.540	2
000.55	000.550	3	000.550	000.550	3
000.56	000.560	4	000.560	000.560	4
000.57	000.570	5	000.570	000.570	5
000.58	000.580	6	000.580	000.580	6
000.59	000.590	7	000.590	000.590	7
000.60	000.600	8	000.600	000.600	8
000.61	000.610	9	000.610	000.610	9
000.62	000.620	0	000.620	000.620	0
000.63	000.630	1	000.630	000.630	1
000.64	000.640	2	000.640	000.640	2
000.65	000.650	3	000.650	000.650	3
000.66	000.660	4	000.660	000.660	4
000.67	000.670	5	000.670	000.670	5
000.68	000.680	6	000.680	000.680	6
000.69	000.690	7	000.690	000.690	7
000.70	000.700	8	000.700	000.700	8
000.71	000.710	9	000.710	000.710	9
000.72	000.720	0	000.720	000.720	0
000.73	000.730	1	000.730	000.730	1
000.74	000.740	2	000.740	000.740	2
000.75	000.750	3	000.750	000.750	3
000.76	000.760	4	000.760	000.760	4

TABLE XIV--Continued

Point	X	Y	Point	X	Y
9-1	-239.830	-143.932	11-1	-240.042	-240.090
2	-191.822	-143.905	2	-191.928	-239.958
3	-143.858	-143.900	3	-143.890	-239.908
4	-95.912	-143.908	4	-95.908	-239.832
5	-47.955	-143.950	5	-47.945	-239.842
6	0.028	-143.945	6	0.030	-239.835
7	48.028	-143.915	7	48.012	-239.828
8	95.982	-143.930	8	95.988	-239.872
9	143.940	-143.908	9	143.972	-239.910
10	191.895	-143.905	10	192.002	-239.928
11	239.920	-143.955	11	240.155	-240.152
10-1	-238.892	-191.980			
2	-191.855	-191.915			
3	-143.860	-191.895			
4	-95.888	-191.865			
5	-47.930	-191.900			
6	0.038	-191.900			
7	48.010	-191.885			
8	95.975	-191.902			
9	143.952	-191.910			
10	191.955	-191.940			
11	240.022	-192.025			

TABLE XV

GRID 378 PLATE 50, AVERAGE DISTANCES FROM CENTER IN MM AT
MODEL SCALE

Point	X	Y	Point	X	Y
1-1	-239.978	239.970	5-1	-239.772	47.918
2	-191.895	239.882	2	-191.830	47.930
3	-143.870	239.810	3	-143.920	47.948
4	-95.890	239.780	4	-95.990	47.990
5	-47.938	239.775	5	-48.008	48.005
6	0.020	239.795	6	0.020	48.030
7	47.938	239.795	7	48.038	48.032
8	95.940	239.805	8	96.020	48.000
9	143.925	239.845	9	143.958	47.980
10	191.960	239.912	10	191.885	47.965
11	240.092	240.045	11	239.860	47.935
2-1	-239.880	191.890	6-1	-239.762	- 0.038
2	-191.828	191.822	2	-191.825	- 0.030
3	-143.842	191.812	3	-143.922	- 0.018
4	-96.892	191.832	4	-95.985	0.002
5	-47.940	191.838	5	-48.020	- 0.010
6	0.010	191.858	6	0	0
7	47.978	191.850	7	48.050	0.015
8	195.940	191.835	8	96.038	0.005
9	143.895	191.835	9	143.972	0.008
10	191.900	191.865	10	191.898	0.008
11	239.975	191.925	11	239.865	- 0.010
3-1	-239.802	143.870	7-1	-239.755	- 48.012
2	-191.805	143.848	2	-191.795	- 48.012
3	-143.855	143.860	3	-143.888	- 48.012
4	-95.922	143.908	4	-95.948	- 48.020
5	-47.962	143.922	5	-47.988	- 48.040
6	0.025	143.940	6	0.045	- 48.035
7	47.995	143.948	7	48.075	- 48.020
8	95.958	143.918	8	96.055	- 48.010
9	143.902	143.890	9	143.980	- 47.985
10	191.858	143.878	10	191.915	- 47.975
11	239.888	143.912	11	239.885	- 48.005
4-1	-239.775	95.880	8-1	-239.775	- 95.965
2	-191.802	95.888	2	-191.808	- 95.960
3	-143.888	95.912	3	-143.868	- 95.960
4	-95.940	95.962	4	-95.935	- 95.972
5	-47.972	95.985	5	-47.968	- 96.005
6	0.020	96.008	6	0.030	- 96.015
7	48.020	96.005	7	48.035	- 95.982
8	95.998	95.962	8	96.008	- 95.995
9	143.945	95.942	9	143.958	- 95.960
10	192.875	95.920	10	191.898	- 95.940
11	239.860	95.908	11	239.896	- 95.972

[illegible]

TABLE XV--Continued

Point	X	Y	Point	X	Y
9-1	-239.802	-143.962	11-1	-240.005	-240.122
2	-191.782	-143.930	2	-191.902	-240.002
3	-143.830	-143.915	3	-143.888	-239.930
4	-95.888	-143.918	4	-95.892	-239.882
5	-47.932	-143.952	5	-47.918	-239.872
6	0.052	-143.938	6	0.050	-239.858
7	48.035	-143.922	7	48.030	-239.840
8	96.008	-143.935	8	96.010	-239.895
9	143.952	-143.910	9	143.988	-239.928
10	191.912	-143.910	10	192.020	-239.995
11	239.942	-143.980	11	240.175	-240.158
10-1	-239.878	-192.012			
2	-191.832	-191.950			
3	-143.830	-191.918			
4	-95.878	-191.890			
5	-47.905	-191.908			
6	0.068	-191.900			
7	48.035	-191.888			
8	96.000	-191.910			
9	143.972	-191.915			
10	191.975	-191.950			
11	240.040	-192.048			

TABLE XVI

GRID 377 PLATE 49, DISTORTION IN MICRONS AT MODEL SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	20	23	5-1	-198	-22	9-1	- 91	20
2	-128	18	2	-151	-35	2	-198	-36
3	-205	22	3	- 74	-33	3	-158	-19
4	-225	37	4	- 13	-27	4	-118	-15
5	-210	30	5	- 2	-23	5	- 59	-13
6	-192	35	6	12	2	6	- 50	-21
7	-189	32	7	19	17	7	- 73	-26
8	-186	31	8	- 13	25	8	- 80	- 6
9	-189	43	9	- 70	21	9	-123	- 7
10	- 74	22	10	-148	16	10	-162	0
11	+118	37	11	-178	24	11	-111	12
2-1	-136	5	6-1	-212	-28	10-1	- 94	-56
2	-207	-11	2	-150	-30	2	-152	-39
3	-208	19	3	- 62	-28	3	-166	-38
4	-201	55	4	5	-18	4	-157	-28
5	-178	- 6	5	- 32	-12	5	-107	- 3
6	-155	10	6	0	0	6	-105	-30
7	-158	19	7	40	-12	7	-125	-25
8	-178	13	8	- 8	2	8	-116	-12
9	-195	15	9	- 45	5	9	-127	- 5
10	-164	6	10	-132	10	10	-125	12
11	- 58	21	11	-168	10	11	4	4
3-1	-187	6	7-1	-199	-30	11-1	105	-47
2	-219	- 8	2	-153	-44	2	- 73	-44
3	-188	- 4	3	- 66	-38	3	-156	-37
4	-122	- 7	4	- 8	-33	4	-183	-33
5	- 76	7	5	46	-28	5	- 78	-39
6	- 65	2	6	55	- 8	6	-170	-35
7	- 65	11	7	46	- 4	7	-176	-44
8	-112	12	8	36	27	8	-118	-31
9	-156	15	9	33	26	9	- 98	-30
10	-195	13	10	-115	24	10	35	15
11	-141	18	11	-146	35	11	198	-15
4-1	-219	-15	8-1	-188	-17			
2	-212	-26	2	-172	-36			
3	-137	-26	3	- 95	-34			
4	- 71	-14	4	- 30	-23			
5	- 52	-12	5	29	-19			
6	- 25	15	6	28	-18			
7	- 17	25	7	10	-16			
8	-45	17	8	- 12	6			
9	- 99	30	9	- 79	3			
10	- 75	66	10	-146	26			
11	-166	42	11	- 44	-24			

[illegible]

TABLE XVII

GRID 378 PLATE 49, DISTORTION IN MICRONS AT MODEL SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	17	0	5-1	-203	-23	9-1	-193	-24
2	-127	12	2	-153	-35	2	-202	-27
3	-197	23	3	-80	-38	3	-150	-26
4	-223	26	4	-14	-33	4	-119	-17
5	-217	23	5	5	-32	5	-65	-3
6	-205	18	6	10	-10	6	-58	8
7	-196	14	7	24	-7	7	-67	-26
8	-187	19	8	-14	25	8	-75	-14
9	-164	14	9	-169	-12	9	-128	0
10	-62	12	10	-151	6	10	-164	-15
11	113	25	11	-177	8	11	-122	2
2-1	-130	-4	6-1	-218	-25	10-1	-96	-49
2	-204	-19	2	-152	-32	2	-162	-42
3	-217	-8	3	-60	-22	3	-167	-40
4	-200	-13	4	0	-22	4	-198	-32
5	-180	-16	5	38	-28	5	-109	-24
6	-158	-2	6	0	0	6	-100	-25
7	-156	4	7	35	-10	7	-134	-32
8	-183	8	8	35	18	8	-113	-18
9	-195	-2	9	-55	-5	9	-132	-10
10	-168	-5	10	-132	-10	10	-132	-12
11	-59	17	11	-168	0	11	-6	-10
3-1	-180	2	7-1	-216	-38	11-1	102	-44
2	-212	-13	2	-163	-48	2	-83	-43
3	-187	-18	3	-69	-46	3	-144	-42
4	-105	5	4	-11	-32	4	-184	-34
5	-89	-4	5	32	-40	5	-171	-37
6	-78	-5	6	45	-10	6	-172	-35
7	-74	2	7	51	2	7	-175	-47
8	-108	9	8	38	28	8	-123	-38
9	-161	2	9	-25	12	9	-94	-27
10	-190	-13	10	-107	15	10	-8	-32
11	-136	-18	11	-119	24	11	212	-7
4-1	-212	-28	8-1	-100	8			
2	-211	-30	2	-177	-36			
3	-140	-20	3	-100	-30			
4	-72	-20	4	-34	-23			
5	-50	-23	5	20	-26			
6	-30	0	6	38	-20			
7	-20	18	7	6	-11			
8	-55	24	8	-16	2			
9	-104	29	9	-82	-8			
10	-172	12	10	-151	-12			
11	-168	17	11	-150	-3			

TABLE XVIII

GRID 377 PLATE 50, DISTORTION IN MICRONS AT MODEL SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	- 9	40	5-1	-215	- 9	9-1	-180	-30
2	-132	36	2	-170	-20	2	-199	-32
3	-199	35	3	- 88	-13	3	-171	-30
4	-223	42	4	- 9	-10	4	-126	-22
5	-213	36	5	- 40	24	5	- 61	-27
6	-195	35	6	25	5	6	- 55	-28
7	-139	30	7	44	12	7	- 72	-53
8	-160	31	8	- 7	19	8	- 68	-24
9	-107	6	9	- 60	23	9	-107	-23
10	76	- 7	10	-124	21	10	-142	-13
11	132	40	11	-157	32	11	- 91	4
2-1	-142	14	6-1	-225	- 5	10-1	- 96	- 52
2	-214	14	2	-160	-12	2	-163	-43
3	-222	22	3	- 70	-10	3	-168	-50
4	-144	53	4	0	8	4	-171	-40
5	-165	33	5	38	-15	5	-113	-44
6	-132	20	6	0	0	6	-100	-38
7	-143	26	7	42	- 5	7	-109	-37
8	-167	28	8	22	10	8	- 96	-22
9	-172	40	9	- 42	15	9	-100	-16
10	-145	42	10	-108	10	10	- 74	-11
11	- 55	52	11	-150	20	11	34	7
3-1	-200	10	7-1	-209	-30	11-1	94	-33
2	-231	- 7	2	-186	3	2	- 78	-30
3	-190	8	3	- 62	-40	3	-127	-53
4	-116	6	4	- 12	-30	4	-187	-14
5	- 95	39	5	25	-34	5	-166	-24
6	- 65	18	6	30	-28	6	-165	-30
7	-14	0	7	62	-46	7	-166	-46
8	- 97	17	8	46	12	8	-123	-36
9	-144	37	9	- 22	13	9	- 91	-22
10	-136	16	10	- 97	23	10	- 56	-46
11	- 97	-33	11	-120	34	11	217	- 3
4-1	-139	-47	8-1	-195	-21			
2	-220	- 7	2	-181	-22			
3	-140	5	3	-105	- 8			
4	- 64	6	4	- 48	- 6			
5	- 32	9	5	14	- 9			
6	- 10	20	6	20	- 2			
7	- 5	25	7	0	-16			
8	- 56	16	8	- 6	10			
9	- 90	14	9	- 65	2			
10	-153	26	10	-126	10			
11	-172	30	11	-118	21			

[illegible]

TABLE XIX

GRID 378 PLATE 50, DISTORTION IN MICRONS AT MODEL SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	-36	6	5-1	-240	-36	9-1	-206	-42
2	-157	8	2	-182	-27	2	-216	-75
3	-229	14	3	-92	-24	3	-180	-60
4	-245	20	4	-13	-5	4	-130	-48
5	-232	16	5	9	-3	5	-66	-50
6	-205	20	6	30	20	6	-62	-52
7	-213	22	7	38	4	7	-63	-57
8	-203	16	8	18	9	8	-34	-57
9	-172	15	9	-46	7	9	-97	-30
10	-94	24	10	-120	7	10	-124	-19
11	82	20	11	-350	37	11	-60	16
2-1	-163	11	6-1	-238	-38	10-1	-102	-66
2	-247	18	2	-175	-30	2	-170	-72
3	-244	14	3	-78	-18	3	-168	-87
4	-198	21	4	-15	2	4	-153	-60
5	-171	18	5	20	-10	5	-112	-70
6	-142	10	6	0	0	6	-100	-32
7	-150	15	7	50	-15	7	-100	-60
8	-174	20	8	38	-5	8	-80	-40
9	-196	15	9	-28	-28	9	-84	-29
10	-166	24	10	-102	-8	10	-80	-40
11	-66	43	11	-135	10	11	60	12
3-1	-225	-10	7-1	-237	-60	11-1	90	-80
2	-242	-7	2	-195	-62	2	-59	-78
3	-202	4	3	-102	-46	3	-118	-60
4	-125	22	4	-37	-41	4	-150	-46
5	-86	12	5	-6	-12	5	-141	-46
6	-60	25	6	35	-45	6	-142	-50
7	-51	12	7	67	-38	7	-152	-60
8	-92	11	8	54	-16	8	-93	-46
9	-140	15	9	-24	-8	9	-68	-26
10	-187	12	10	-88	-4	10	8	-19
11	-141	17	11	-111	28	11	237	-12
4-1	-253	-38	8-1	-222	-51			
2	-226	-12	2	-189	-51			
3	-141	17	3	-132	-40			
4	-68	16	4	-72	-20			
5	-26	19	5	-9	-30			
6	8	20	6	15	-30			
7	14	16	7	0	-38			
8	-28	26	8	49	-57			
9	-77	18	9	-57	-10			
10	-148	16	10	-117	-7			
11	-164	34	11	-104	12			

TABLE XX

PLATE 49, AVERAGE DISTORTION IN MICRONS AT PHOTO SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	8	5	5-1	-34	-9	9-1	-59	-1
2	-53	6	2	-64	-15	2	-83	-13
3	-84	9	3	-32	-15	3	-64	-9
4	-93	13	4	-6	-13	4	-49	-7
5	-89	11	5	1	-11	5	-26	-3
6	-84	11	6	5	-2	6	-23	-3
7	-80	10	7	9	2	7	-29	-11
8	-78	10	8	-6	10	8	-32	-4
9	-74	12	9	-50	2	9	-52	-2
10	-28	7	10	-62	5	10	-63	-3
11	48	13	11	-74	7	11	-49	3
2-1	-55	0	6-1	-90	-11	10-1	-40	-22
2	-86	6	2	-63	-13	2	-65	-17
3	-89	2	3	-27	-10	3	-69	-16
4	-84	9	4	1	-8	4	-74	-13
5	-75	-5	5	1	-8	5	-45	-6
6	-65	2	6	0	0	6	-43	-11
7	-65	5	7	16	-5	7	-54	-12
8	-75	4	8	-13	4	8	-48	-6
9	-81	3	9	-21	0	9	-54	-3
10	-69	0	10	-55	0	10	-54	0
11	-24	8	11	-70	2	11	0	-1
3-1	-76	2	7-1	-86	-14	11-1	43	-19
2	-90	-4	2	-66	-19	2	-33	-18
3	-78	-5	3	-28	-18	3	-63	-16
4	-47	0	4	-4	-14	4	-76	-14
5	-34	1	5	16	-14	5	-52	-16
6	-30	-1	6	21	0	6	-71	-15
7	-29	3	7	20	6	7	-73	-19
8	-46	4	8	15	11	8	-50	-14
9	-66	3	9	1	8	9	-40	-12
10	-80	0	10	-46	8	10	6	-4
11	-58	0	11	-55	12	11	85	-5
4-1	-90	-9	8-1	-60	-2			
2	-88	-12	2	-73	-15			
3	-58	-10	3	-41	-13			
4	-30	-7	4	-13	-10			
5	-21	-7	5	10	-10			
6	-11	3	6	14	-8			
7	-8	9	7	3	-6			
8	-21	9	8	-8	2			
9	-42	12	9	-34	-1			
10	-51	16	10	-62	3			
11	-70	12	11	-40	-6			

Page	Author	Title	Year	Price	Notes
101	John Doe	The Great Gatsby	1925	\$5.00	First Edition
102	John Doe	The Great Gatsby	1925	\$5.00	First Edition
103	John Doe	The Great Gatsby	1925	\$5.00	First Edition
104	John Doe	The Great Gatsby	1925	\$5.00	First Edition
105	John Doe	The Great Gatsby	1925	\$5.00	First Edition
106	John Doe	The Great Gatsby	1925	\$5.00	First Edition
107	John Doe	The Great Gatsby	1925	\$5.00	First Edition
108	John Doe	The Great Gatsby	1925	\$5.00	First Edition
109	John Doe	The Great Gatsby	1925	\$5.00	First Edition
110	John Doe	The Great Gatsby	1925	\$5.00	First Edition

TABLE XXI

PLATE 50, AVERAGE DISTORTION IN MICRONS AT PHOTO SCALE

Point	Radial	Tang.	Point	Radial	Tang.	Point	Radial	Tang.
1-1	-9	10	5-1	-93	-10	9-1	-80	-15
2	-60	9	2	-73	-10	2	-87	-22
3	-89	10	3	-38	-8	3	-73	-19
4	-98	13	4	-5	-3	4	-53	-15
5	-93	11	5	-6	4	5	-26	-16
6	-83	11	6	11	5	6	-24	-17
7	-73	11	7	17	3	7	-28	-23
8	-80	10	8	2	6	8	-21	-17
9	-58	5	9	-22	6	9	-43	-11
10	-4	4	10	-51	6	10	-41	-25
11	45	13	11	-64	14	11	-32	4
2-1	-64	5	6-1	-97	-9	10-1	-41	-25
2	-96	7	2	-70	-9	2	-69	-24
3	-97	8	3	-33	-6	3	-70	-29
4	-71	15	4	-3	2	4	-68	-21
5	-70	11	5	12	-5	5	-47	-24
6	-57	6	6	0	0	6	-42	-15
7	-61	9	7	19	-4	7	-44	-20
8	-71	10	8	13	1	8	-37	-13
9	-77	11	9	-15	2	9	-38	-9
10	-65	14	10	-44	0	10	-32	-11
11	-25	20	11	-59	6	11	20	4
3-1	-89	0	7-1	-93	-19	11-1	38	-24
2	-99	-3	2	-79	-12	2	-29	-23
3	-82	3	3	-38	-18	3	-51	-24
4	-50	6	4	-10	-15	4	-70	-13
5	-38	11	5	4	-10	5	-64	-15
6	-26	9	6	15	-15	6	-64	-17
7	-14	3	7	31	-18	7	-66	-22
8	-39	6	8	21	-1	8	-45	-17
9	-59	11	9	-10	1	9	-33	-10
10	-78	6	10	-39	4	10	-10	-14
11	-50	-3	11	-48	13	11	95	-3
4-1	-82	-18	8-1	-87	-15			
2	-93	-4	2	-77	-15			
3	-59	5	3	-49	-10			
4	-28	5	4	-25	-5			
5	-12	6	5	1	-8			
6	0	8	6	7	-7			
7	2	9	7	0	-11			
8	-18	9	8	9	-10			
9	-35	7	9	-25	-2			
10	-63	9	10	-51	1			
11	-70	13	11	-46	7			

1. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 2. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 3. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 4. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 5. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 6. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 7. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 8. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 9. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$
 10. $\frac{1}{2} \frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m v \frac{dv}{dt}$

TABLE XXII

PLATE 49, CORRECTED TANGENTIAL
DISTORTION IN MICRONS

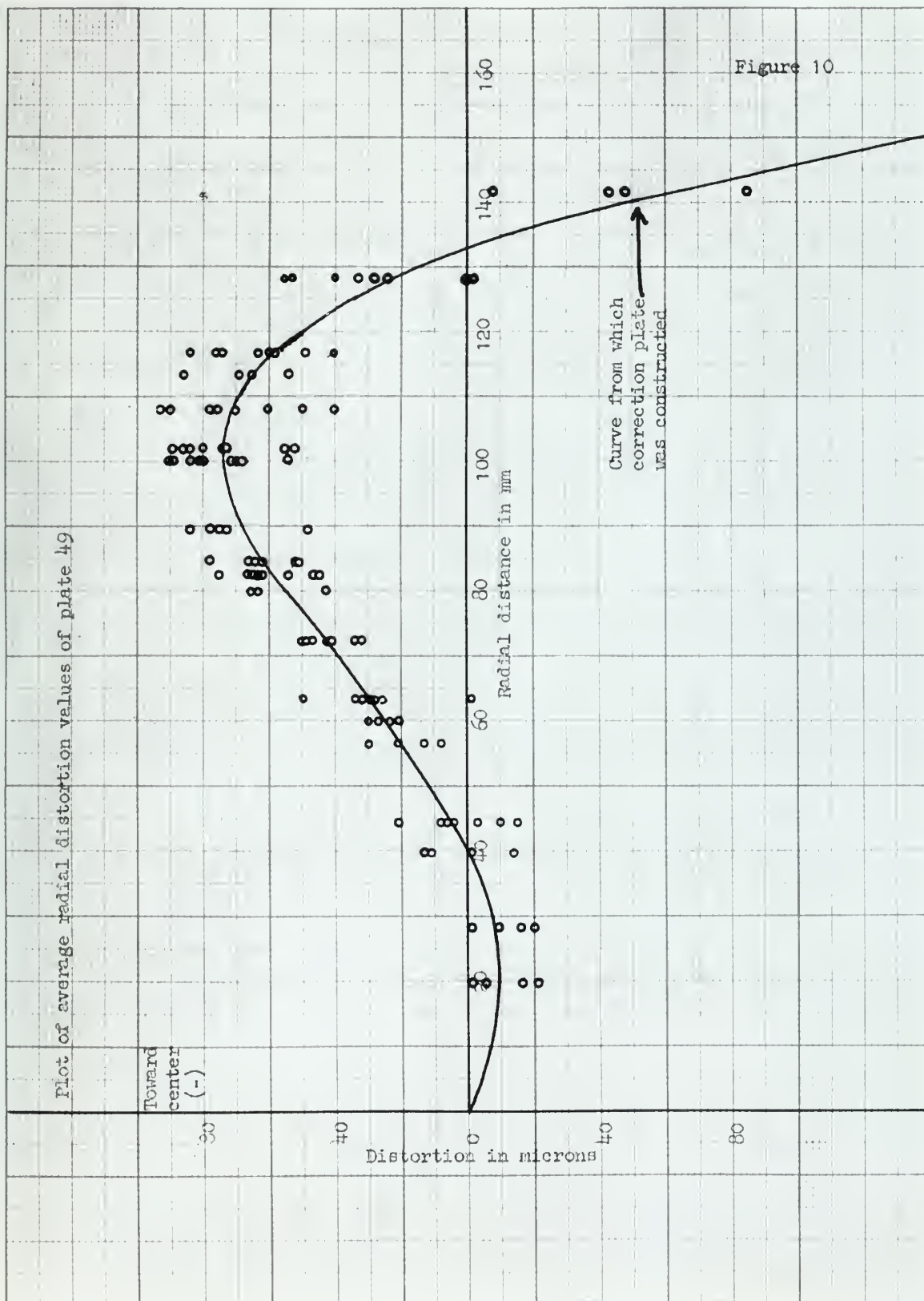
Pt. Dist.	Pt. Dist.	Pt. Dist.
1-1	12	5-1 - 4
2	12	2 -11
3	15	3 -12
4	18	4 -11
5	16	5 -10
6	16	6 - 1
7	15	7 3
8	15	8 12
9	18	9 5
10	13	10 9
11	20	11 12
2-1	6	6-1 - 6
2	12	2 - 9
3	7	3 - 7
4	13	4 - 6
5	- 1	5 - 7
6	6	6 0
7	9	7 - 4
8	8	8 6
9	8	9 3
10	6	10 4
11	14	11 7
3-1	8	7-1 - 9
2	1	2 -15
3	- 1	3 -15
4	4	4 -12
5	4	5 -13
6	2	6 1
7	6	7 7
8	8	8 13
9	7	9 11
10	5	10 12
11	6	11 17
4-1	- 4	8-1 3
2	- 8	2 -11
3	- 6	3 - 9
4	- 4	4 - 7
5	- 5	5 - 8
6	5	6 - 6
7	11	7 - 4
8	12	8 5
9	16	9 3
10	20	10 7
11	17	11 - 1

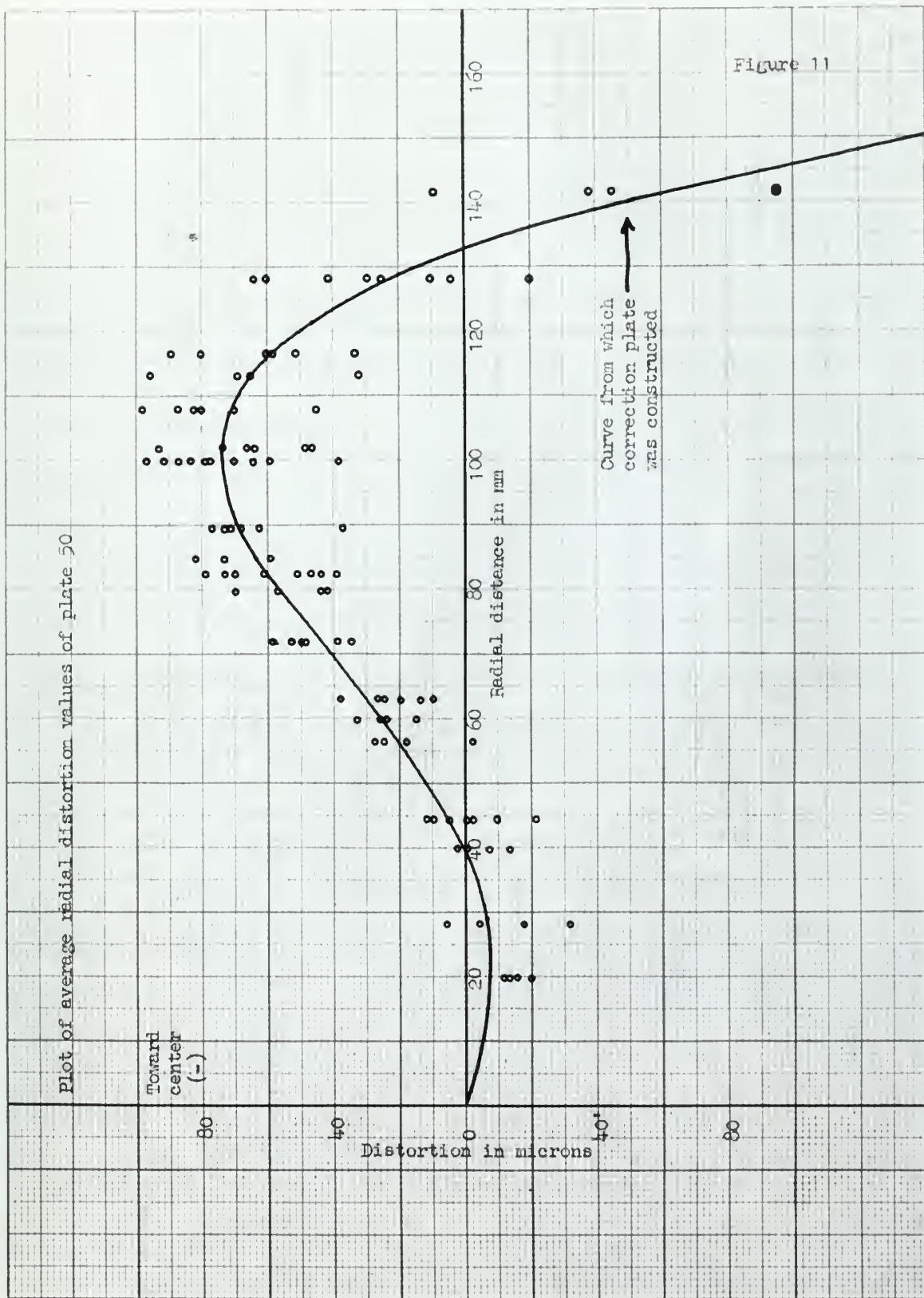
TABLE XXIII

PLATE 50, CORRECTED TANGENTIAL
DISTORTION IN MICRONS

Pt. Dist.	Pt. Dist.	Pt. Dist.
1-1	16	5-1 - 6
2	14	2 - 7
3	15	3 - 5
4	17	4 - 1
5	15	5 5
6	15	6 6
7	15	7 4
8	14	8 8
9	10	9 9
10	9	10 9
11	19	11 18
2-1	10	6-1 - 5
2	12	2 - 6
3	12	3 - 3
4	19	4 4
5	14	5 - 4
6	9	6 0
7	12	7 - 3
8	14	8 3
9	15	9 5
10	19	10 3
11	25	11 10
3-1	5	7-1 -15
2	1	2 - 9
3	7	3 -15
4	9	4 -13
5	14	5 - 9
6	12	6 -14
7	6	7 -17
8	9	8 1
9	15	9 4
10	10	10 7
11	2	11 17
4-1	-14	8-1 -11
2	0	2 -11
3	8	3 - 7
4	7	4 - 3
5	8	5 - 6
6	10	6 - 5
7	11	7 - 9
8	11	8 - 8
9	10	9 1
10	13	10 5
11	17	11 11

Year	Month	Day	Time	Location	Remarks
1901	Jan	1	10:00	St. Paul	Arrived from Chicago
1901	Jan	2	10:00	St. Paul	Left for Chicago
1901	Jan	3	10:00	St. Paul	Arrived from Chicago
1901	Jan	4	10:00	St. Paul	Left for Chicago
1901	Jan	5	10:00	St. Paul	Arrived from Chicago
1901	Jan	6	10:00	St. Paul	Left for Chicago
1901	Jan	7	10:00	St. Paul	Arrived from Chicago
1901	Jan	8	10:00	St. Paul	Left for Chicago
1901	Jan	9	10:00	St. Paul	Arrived from Chicago
1901	Jan	10	10:00	St. Paul	Left for Chicago
1901	Jan	11	10:00	St. Paul	Arrived from Chicago
1901	Jan	12	10:00	St. Paul	Left for Chicago
1901	Jan	13	10:00	St. Paul	Arrived from Chicago
1901	Jan	14	10:00	St. Paul	Left for Chicago
1901	Jan	15	10:00	St. Paul	Arrived from Chicago
1901	Jan	16	10:00	St. Paul	Left for Chicago
1901	Jan	17	10:00	St. Paul	Arrived from Chicago
1901	Jan	18	10:00	St. Paul	Left for Chicago
1901	Jan	19	10:00	St. Paul	Arrived from Chicago
1901	Jan	20	10:00	St. Paul	Left for Chicago
1901	Jan	21	10:00	St. Paul	Arrived from Chicago
1901	Jan	22	10:00	St. Paul	Left for Chicago
1901	Jan	23	10:00	St. Paul	Arrived from Chicago
1901	Jan	24	10:00	St. Paul	Left for Chicago
1901	Jan	25	10:00	St. Paul	Arrived from Chicago
1901	Jan	26	10:00	St. Paul	Left for Chicago
1901	Jan	27	10:00	St. Paul	Arrived from Chicago
1901	Jan	28	10:00	St. Paul	Left for Chicago
1901	Jan	29	10:00	St. Paul	Arrived from Chicago
1901	Jan	30	10:00	St. Paul	Left for Chicago
1901	Jan	31	10:00	St. Paul	Arrived from Chicago





CONSTRUCTION OF COORDINATE ERROR CURVES

Using the metrogon correction plate curve, as specified for construction, as the reference, the curves of elevation error were computed and tabulated in Table VII. Using these values and the equations for p_y , dX'' and e_0 derived in Chapter II, values were computed for points in the model sufficient to construct error curves. Lens 13 is the worst of the 25 lenses in point of view of resultant elevation errors and lens 18 the best. Table XXIV contains these computations which were done for the upper half of the model only due to the symmetry about the X axis. Figures 12 through 20 are the constructed curves. These curves are computed on the basis of an assumed elevation of 4,000 meters above the terrain just as all examples throughout the thesis have been.

In order to provide a more realistic picture of the anticipated errors, the elements of mathematical relative orientation were computed for a dependent pair orientation procedure using the following formulae:

$$d\phi_2 = \frac{3183h}{b^4}(p_3 - p_4 - p_5 + p_6)$$

$$d\omega_2 = \frac{1591h}{d^2}(-2p_1 - 2p_2 + p_3 + p_4 + p_5 + p_6)$$

$$d\kappa_2 = \frac{2122}{b}(p_1 - p_2 + p_3 - p_4 + p_5 - p_6)$$

$$dbs_2 = \frac{h}{2d}(p_6 - p_4)$$

Under the original provisions of the Constitution, the President was elected by the electors in the several States. The electors were chosen by the people of each State, and their number was equal to the number of Representatives and Senators from that State. The electors met in their respective States, and cast their votes for President and Vice-President. The person who received a majority of the electoral votes was elected President. The original provisions of the Constitution provided for a four-year term of office for the President, and for the possibility of re-election. The original provisions also provided for the President to have the power to appoint and remove officers of the United States, and to grant pardons and reprieves. The original provisions of the Constitution were amended by the first ten amendments, known as the Bill of Rights. These amendments were added to the original Constitution to protect the rights of the people and to limit the power of the government. The original provisions of the Constitution have been amended many times since the Bill of Rights, and the current Constitution is the result of these amendments.

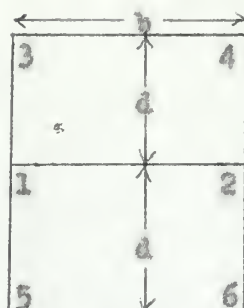
In order to provide a more detailed picture of the original provisions of the Constitution, the following table shows the number of electors in each State at the time of the first election in 1788. The table also shows the number of Representatives and Senators from each State at that time. The total number of electors was 69, and the total number of Representatives and Senators was 113.

State	Electors	Representatives	Senators
Delaware	3	1	2
Pennsylvania	7	6	2
New Jersey	3	3	2
Georgia	3	3	2
Massachusetts	7	8	2
Connecticut	3	3	2
New York	11	13	3
Virginia	7	10	3
North Carolina	3	5	2
South Carolina	3	5	2
Florida	3	3	2
Alabama	3	3	2
Mississippi	3	3	2
Louisiana	3	3	2
Texas	3	3	2
Illinois	3	3	2
Indiana	3	3	2
Ohio	3	3	2
Michigan	3	3	2
Wisconsin	3	3	2
Minnesota	3	3	2
Iowa	3	3	2
Missouri	3	3	2
Arkansas	3	3	2
Kentucky	3	3	2
Tennessee	3	3	2
Alabama	3	3	2
Georgia	3	3	2
Florida	3	3	2
South Carolina	3	3	2
North Carolina	3	3	2
Virginia	7	10	3
New York	11	13	3
Connecticut	3	3	2
Massachusetts	7	8	2
Georgia	3	3	2
New Jersey	3	3	2
Pennsylvania	7	6	2
Delaware	3	1	2

Where: Quantities are in centesimal minutes and mm.

p = parallax at given point in model

h = projector to model distance



Model

Points 3, 4, 5, 6 are approximately 1 cm from the respective upper and lower edges of the photo.

Points 1 and 2 are approximately the nadir points.

<u>Lens</u>	<u>P₁</u>	<u>P₂</u>	<u>P₃</u>	<u>P₄</u>	<u>P₅</u>	<u>P₆</u>
13	0	0	-.037	.037	.037	-.037 mm
Ave.	0	0	.0025	-.0025	-.0025	.0025
18	0	0	.0042	-.0042	-.0042	.0042

<u>Lens</u>	<u>dφ₂</u>	<u>dω₂</u>	<u>dκ₂</u>	<u>dbx₂</u>
13	-7.88°	0	0	-.0564 mm
Ave.	.533	0	0	.0038
18	.895	0	0	.0064

These elements were then introduced into the following equation to solve for the change in e_2 , the elevation error of the right projector, caused by relative orientation:

$$de = \left[\frac{h^2}{b} + \frac{(X-b)^2}{b} \right] d\phi_2 - \frac{(X-b)Y}{b} d\omega_2 - \frac{hY}{b} d\kappa_2 + \frac{(X-b)}{b} dbx_2$$

and the internal dimensions of the rectangular vessel
 were as follows: length of cylinder = 3
 diameter of cylinder = 1

Assuming that the cylinder
 was 1 inch in diameter
 and 3 inches in length
 the volume of the cylinder
 was 2.356 cubic inches.



Diagram

Time	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.
11	70.0	70.0	70.0	70.0	70.0	70.0
12	70.0	70.0	70.0	70.0	70.0	70.0
13	70.0	70.0	70.0	70.0	70.0	70.0
14	70.0	70.0	70.0	70.0	70.0	70.0
15	70.0	70.0	70.0	70.0	70.0	70.0
16	70.0	70.0	70.0	70.0	70.0	70.0
17	70.0	70.0	70.0	70.0	70.0	70.0
18	70.0	70.0	70.0	70.0	70.0	70.0
19	70.0	70.0	70.0	70.0	70.0	70.0
20	70.0	70.0	70.0	70.0	70.0	70.0
21	70.0	70.0	70.0	70.0	70.0	70.0
22	70.0	70.0	70.0	70.0	70.0	70.0
23	70.0	70.0	70.0	70.0	70.0	70.0
24	70.0	70.0	70.0	70.0	70.0	70.0
25	70.0	70.0	70.0	70.0	70.0	70.0
26	70.0	70.0	70.0	70.0	70.0	70.0
27	70.0	70.0	70.0	70.0	70.0	70.0
28	70.0	70.0	70.0	70.0	70.0	70.0
29	70.0	70.0	70.0	70.0	70.0	70.0
30	70.0	70.0	70.0	70.0	70.0	70.0

These observations were taken at intervals of 10 minutes
 and the results are as follows: The temperature of the
 water in the cylinder was 70.0 degrees Fahrenheit at
 the first observation, and it remained constant at
 70.0 degrees Fahrenheit throughout the entire
 experiment.

$$Q = \left(\frac{1}{2} + \frac{1}{2} \right) \times \left(\frac{1}{2} + \frac{1}{2} \right) \times \left(\frac{1}{2} + \frac{1}{2} \right) = 1$$

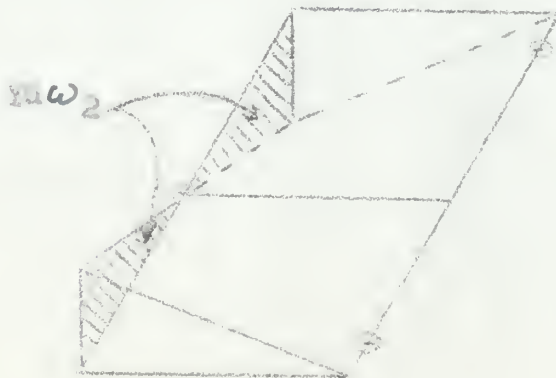
As can be seen from the above table of elements of orientation, all elements except $d\phi_2$ and dbz_2 are zero due to the symmetry of the parallax resulting from the model composed of two vertical photos. The dbz_2 element is retained in the computations even though it could be corrected for in the absolute orientation, as it causes a straight line tilt of the model about the Y axis as shown below:



The h^2/b part of the $d\phi_2$ coefficient is a constant elevation change, thus could be compensated in absolute orientation, and the $(X-b)^2/b$ is the variable as shown below:



The absolute orientation will be carried out using three points as near as possible to the points circled in the above diagram in order to compensate in the absolute orientation, as near as possible, for the error in $d\phi_2$ brought about by parallax caused by uncompensated distortion in the camera lens. Also this scheme of points will avoid correcting for any error in $d\omega_2$ caused by distortion parallax, as can be seen from the following diagram of elevation error caused by $d\omega_2$:





The diagram represents a cross-section of a geological structure. It shows a rectangular area with internal lines and labels. The labels are as follows:

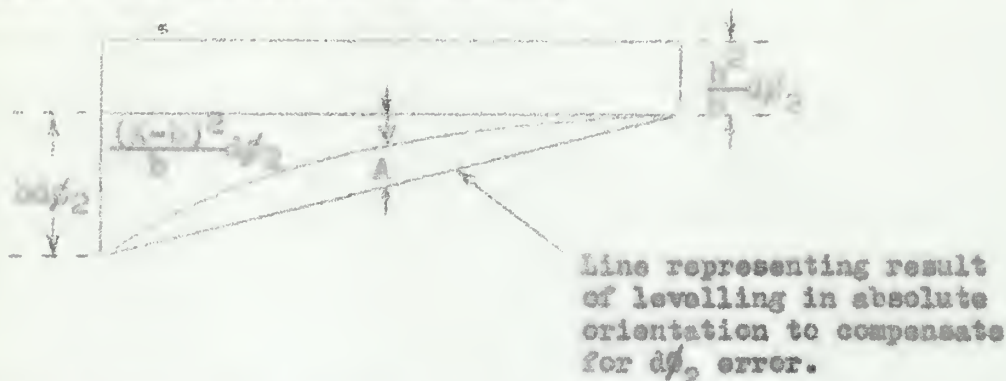
- Top left: $\frac{1}{2}$
- Top right: $\frac{1}{2}$
- Bottom left: $\frac{1}{2}$
- Bottom right: $\frac{1}{2}$

The diagram is a schematic representation of a geological structure, showing a rectangular area with internal lines and labels. The labels are as follows:

- Top left: $\frac{1}{2}$
- Top right: $\frac{1}{2}$
- Bottom left: $\frac{1}{2}$
- Bottom right: $\frac{1}{2}$



The effect of the warping caused by a $d\phi_2$ error can be seen in Figures 27 through 29. The elevation errors along the X-axis form a curve with a definite change of slope as can be seen in a diagram of the theoretical situation.



As an indication of the effect of the approximation of $d\phi_2$ in absolute orientation, the magnitude of A, the maximum point of separation, is computed for each of the three lenses:

<u>Lens</u>	<u>A at ground scale in meters</u>	<u>Error as a fraction of flying height</u>
13	0.742	1:5400
Ave.	0.050	1:90000
18	0.084	1:47600

Measurement of cross-section graphs through the X-axis of Figures 27 through 29 yields values of A greater than in the above table but approximately equal to A plus the result of dbz_2 at that point. As can be seen from the above table of values, this approximation, in all but the worst lenses, will not introduce errors anywhere near the errors caused by the uncompensated distortion. Measurement of a cross-section through the X-axis of Figure 32, the elevation errors of the actual photography, yielded this curve with a value for A of approximately twice that found for lens 18.

1. The first step in the process of identifying a problem is to define the problem. This involves identifying the symptoms of the problem and determining the scope of the problem. Once the problem has been defined, the next step is to identify the causes of the problem. This involves identifying the factors that are contributing to the problem and determining the underlying causes. Once the causes have been identified, the next step is to develop a plan of action. This involves identifying the steps that need to be taken to solve the problem and determining the resources that will be needed to implement the plan. Finally, the last step in the process is to implement the plan and monitor the results. This involves putting the plan into action and tracking the progress of the solution. Once the problem has been solved, the final step is to evaluate the results and determine if the solution was effective. This involves comparing the results of the solution to the original problem and determining if the problem has been solved. If the problem has not been solved, the process may need to be repeated.

At the same time, it is important to understand that the
the following are not to be confused with the following
the following are not to be confused with the following

Material	Quantity	Unit Price	Total
Concrete	1000	1.50	1500
Rebar	500	2.00	1000
Formwork	200	3.00	600
Labor	100	4.00	400
Transportation	50	1.00	50
Other	10	0.50	5
Total			3555

[illegible]

The computations of δh appear in Table XXVI. The curves of the resultant errors appear in Figures 21 through 29. After this false orientation, which has destroyed the true spatial relationship, the errors depicted in Figures 21 through 29 would represent, approximately, what would be observed in models formed with these lenses, except that the model formed with lens 13 would require extensive adjustment to correct the large amount of y -parallax present. The average lens is probably representative of most metrogon lenses.

As a comparison of the data plotted in Figures 12 through 20 and Figures 21 through 29, the following table of maximum errors is presented, in which the errors are stated as fractional parts of the aircraft elevation:

	<u>Elevation Errors</u>	<u>X-direction Errors</u>
True spatial model Fig. 12-20		
Lens 13	1:1300	1:8000
Average lens	1:5000	1:27000
Lens 18	1:20000	1:65000
Oriented model Fig. 21-29		
Lens 13	1:400	1:4000
Average lens	1:2670	1:16000
Lens 18	1:1600	1:10000

The best elevation accuracy attainable would be approximately three halves that of a second order plotter and one half that in a first order instrument. The relative accuracy of using the above metrogon photography in a first order instrument to that in a second order instrument would be approximately

$$\sqrt{1.5^2 + 3^2} : \sqrt{1.5^2 + 1^2} \text{ or } 1.88:1.$$

For comparison purposes, one stereo model was observed and errors computed in Table XXVII. The curves of these errors are plotted in Figures 30 through 32. The photography was taken by the U. S. Coast and Geodetic Survey with a metrogon lens camera of focal length 152.37 mm at a stated altitude of 13750 feet over the McClure, Ohio, photogrammetric test area. The observations were made in the Wild Autograph A7. Relative orientation was completed in the normal manner using 6 points. Absolute orientation was completed using 3 points as previously discussed to minimize the effect that a warped model, caused by ϕ or ω errors, would have upon the absolute orientation.

Model scale was selected as 1:10,000 in order to provide a desirable position of the model in Z column height. Model scaling was performed using the following set of equations:

$$\Delta S_1^* = S_{o1}^* - S_1^*$$

$$\Delta S_2^* = S_{o2}^* - S_2^*$$

$$\Delta S_3^* = S_{o3}^* - S_3^*$$

S_o^* = observed distance at
model scale

S^* = given distance at
model scale

$$q_1 = \frac{\Delta S_1^*}{S_{o1}^*}$$

$$q_2 = \frac{\Delta S_2^*}{S_{o2}^*}$$

$$q_3 = \frac{\Delta S_3^*}{S_{o3}^*}$$

$$q = 1/3(q_1 + q_2 + q_3)$$

$$bx = bx_o - qbx_o$$

$$by = by_o - qby_o$$

$$bz = bz_o - qbz_o$$



The experiment was carried out in the following manner. The specimen was placed in a container of water and the water level was marked. The specimen was then removed and the water level was again marked. The difference in the two levels was the volume of the specimen. The specimen was then weighed and the weight was divided by the volume to give the density. The density was then compared with the density of the material from which the specimen was made. If the densities were the same, the specimen was made of that material. If the densities were different, the specimen was made of a different material.

The results of the experiment are given in the following table. The first column gives the weight of the specimen in grams. The second column gives the volume of the specimen in cubic centimeters. The third column gives the density of the specimen in grams per cubic centimeter. The fourth column gives the density of the material from which the specimen was made. The fifth column gives the result of the comparison of the two densities.



$$\begin{aligned} \Delta x &= x_2 - x_1 = \Delta x \\ \Delta y &= y_2 - y_1 = \Delta y \\ \Delta z &= z_2 - z_1 = \Delta z \\ \Delta t &= t_2 - t_1 = \Delta t \\ \Delta s &= s_2 - s_1 = \Delta s \\ \Delta v &= v_2 - v_1 = \Delta v \\ \Delta w &= w_2 - w_1 = \Delta w \\ \Delta u &= u_2 - u_1 = \Delta u \\ \Delta p &= p_2 - p_1 = \Delta p \\ \Delta q &= q_2 - q_1 = \Delta q \\ \Delta r &= r_2 - r_1 = \Delta r \\ \Delta s &= s_2 - s_1 = \Delta s \\ \Delta t &= t_2 - t_1 = \Delta t \\ \Delta u &= u_2 - u_1 = \Delta u \\ \Delta v &= v_2 - v_1 = \Delta v \\ \Delta w &= w_2 - w_1 = \Delta w \\ \Delta x &= x_2 - x_1 = \Delta x \\ \Delta y &= y_2 - y_1 = \Delta y \\ \Delta z &= z_2 - z_1 = \Delta z \\ \Delta t &= t_2 - t_1 = \Delta t \\ \Delta s &= s_2 - s_1 = \Delta s \\ \Delta v &= v_2 - v_1 = \Delta v \\ \Delta w &= w_2 - w_1 = \Delta w \\ \Delta u &= u_2 - u_1 = \Delta u \\ \Delta p &= p_2 - p_1 = \Delta p \\ \Delta q &= q_2 - q_1 = \Delta q \\ \Delta r &= r_2 - r_1 = \Delta r \end{aligned}$$

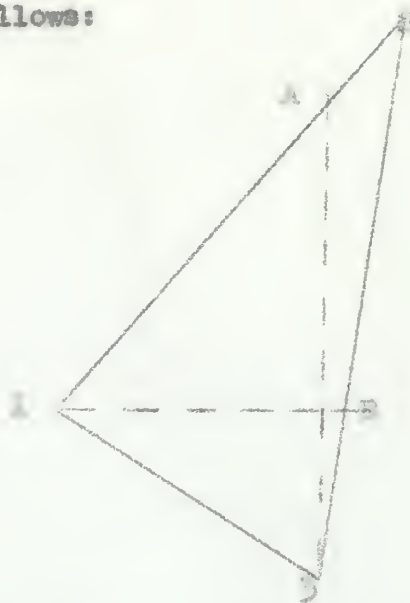
Model levelling was completed as follows:

$$\Delta H_A = \Delta H_1 + \frac{1-A}{1-2}(\Delta H_2 - \Delta H_1)$$

$$\Delta H_B = \Delta H_3 + \frac{3-B}{3-2}(\Delta H_2 - \Delta H_3)$$

$$\omega = \frac{\Delta H_3 - \Delta H_A}{A-3}$$

$$\phi = \frac{\Delta H_B - \Delta H_1}{B-1}$$



Upon completion of orientation, final observations were made on the above 3 points and the following determined:

Actual model scale: 1:9999.12.

Rotation of model necessary to align model with given coordinate system: $\lambda = 1^\circ 42' 52.6$.

Upon completion of observation of all given points in the model, the observed quantities of X and Y were corrected using the following equations, in which m is the scale factor:

$$X' = mX \cos \lambda + mY \sin \lambda$$

$$Y' = mY \cos \lambda - mX \sin \lambda.$$

Consider the following diagram:



$$(x^2 \Delta - y^2 \Delta) \frac{1}{2} \div x^2 \Delta = \frac{1}{2} \Delta$$

$$(x^2 \Delta - y^2 \Delta) \frac{1}{2} \div x^2 \Delta = \frac{1}{2} \Delta$$

$$\frac{x^2 \Delta - y^2 \Delta}{2} = \omega$$

$$\frac{x^2 \Delta - y^2 \Delta}{2} = h$$

We also find that the area of the triangle is equal to the area of the rectangle.

The above is a special case of the general theorem.

THEOREM 1. Let Δ be a triangle.

Then the area of the triangle is equal to the area of the rectangle.

Proof. Consider the triangle Δ with vertices A, B, C .

Let D, E, F be the midpoints of the sides AB, BC, CA respectively.

Then the area of the triangle Δ is equal to the area of the rectangle.

$$\Delta = \frac{1}{2} \times \text{base} \times \text{height}$$

$$\Delta = \frac{1}{2} \times \text{base} \times \text{height}$$

TABLE XXIV

x_{a1} (cm)	x_{a2} (cm)	y_a (cm)
-0.71	- 9.85	1.82
1.26	- 7.88	1.51
-2.46	-11.60	3.12
-0.05	- 9.19	4.00
1.92	- 7.22	3.52
3.49	- 5.65	2.00
-1.37	-10.51	5.83
1.05	- 8.09	5.90
3.00	- 6.14	5.19
-2.53	-11.67	7.58
0.20	- 8.94	8.00
2.59	- 6.55	7.59
-2.18	-11.32	9.77
-0.56	- 9.70	9.99
2.14	- 7.00	9.89
1.78	- 7.36	11.85
7.36	- 1.78	11.85
7.00	- 2.14	9.89
9.70	0.56	9.99
11.32	2.18	9.77
6.55	- 2.59	7.59
8.94	- 0.20	8.00
11.67	2.53	7.58
6.14	- 3.00	5.19
8.09	- 1.05	5.90
10.51	1.37	5.83
5.65	- 3.49	2.00
7.22	- 1.92	3.52
9.19	0.05	4.00
11.60	2.46	3.12
7.88	- 1.26	1.51
9.85	0.71	1.82

x^A (mm)	x^B (mm)	x^C (mm)
20.5	20.5	20.5
21.5	21.5	21.5
22.5	22.5	22.5
23.5	23.5	23.5
24.5	24.5	24.5
25.5	25.5	25.5
26.5	26.5	26.5
27.5	27.5	27.5
28.5	28.5	28.5
29.5	29.5	29.5
30.5	30.5	30.5
31.5	31.5	31.5
32.5	32.5	32.5
33.5	33.5	33.5
34.5	34.5	34.5
35.5	35.5	35.5
36.5	36.5	36.5
37.5	37.5	37.5
38.5	38.5	38.5
39.5	39.5	39.5
40.5	40.5	40.5
41.5	41.5	41.5
42.5	42.5	42.5
43.5	43.5	43.5
44.5	44.5	44.5
45.5	45.5	45.5
46.5	46.5	46.5
47.5	47.5	47.5
48.5	48.5	48.5
49.5	49.5	49.5
50.5	50.5	50.5
51.5	51.5	51.5
52.5	52.5	52.5
53.5	53.5	53.5
54.5	54.5	54.5
55.5	55.5	55.5
56.5	56.5	56.5
57.5	57.5	57.5
58.5	58.5	58.5
59.5	59.5	59.5
60.5	60.5	60.5
61.5	61.5	61.5
62.5	62.5	62.5
63.5	63.5	63.5
64.5	64.5	64.5
65.5	65.5	65.5
66.5	66.5	66.5
67.5	67.5	67.5
68.5	68.5	68.5
69.5	69.5	69.5
70.5	70.5	70.5
71.5	71.5	71.5
72.5	72.5	72.5
73.5	73.5	73.5
74.5	74.5	74.5
75.5	75.5	75.5
76.5	76.5	76.5
77.5	77.5	77.5
78.5	78.5	78.5
79.5	79.5	79.5
80.5	80.5	80.5
81.5	81.5	81.5
82.5	82.5	82.5
83.5	83.5	83.5
84.5	84.5	84.5
85.5	85.5	85.5
86.5	86.5	86.5
87.5	87.5	87.5
88.5	88.5	88.5
89.5	89.5	89.5
90.5	90.5	90.5
91.5	91.5	91.5
92.5	92.5	92.5
93.5	93.5	93.5
94.5	94.5	94.5
95.5	95.5	95.5
96.5	96.5	96.5
97.5	97.5	97.5
98.5	98.5	98.5
99.5	99.5	99.5
100.5	100.5	100.5

TABLE XXIV--Continued

Lens 13

e_1 (m)	e_2 (m)	$e_1 - e_2$ (m)	py (microns)	$\Delta X''$ (m)	$f\Delta X''/x_{a2}$ (m)	e_o (m)
-2.84	-1.54	-1.30	- 5.9	0.065	-0.10	-1.44
-2.84	-2.68	-0.16	- 6.0	-0.011	0.02	-2.70
-3.13	0.55	-3.68	-28.7	0.747	-0.99	1.54
-3.13	-1.54	-1.59	-15.9	0.005	-0.01	-1.53
-3.13	-2.68	-0.45	-4.0	-0.044	0.09	-2.77
-3.13	-3.28	0.15	+ 0.8	0.021	-0.06	-3.22
-3.28	0.55	-3.83	-55.8	0.392	-0.57	1.12
-3.28	-1.54	-1.74	-25.7	-0.105	0.20	-1.74
-3.28	-2.68	-0.60	- 7.8	-0.079	0.20	-2.88
-2.68	-0.09	-2.59	-49.1	0.544	-0.72	0.63
-2.68	0.55	-3.23	-64.6	-0.041	0.07	0.48
-2.68	-1.54	-1.14	-21.6	-0.138	0.32	-1.86
-1.54	0.19	-1.73	-42.3	0.304	-0.41	0.60
-1.54	-0.09	-1.45	-36.2	0.056	-0.09	0
-1.54	0.55	-2.09	-51.7	-0.223	0.49	0.06
0.55	-0.09	0.64	+19.0	0.060	-0.13	0.04
-0.09	0.55	-0.64	-19.0	-0.060	0.52	0.03
0.55	-1.54	2.09	51.7	0.223	-1.60	0.06
-0.09	-1.54	1.45	36.2	-0.056	-1.54	0
0.19	-1.54	1.73	42.3	-0.304	-2.14	0.60
-1.54	-2.68	1.14	21.6	0.138	-0.82	-1.86
0.55	-2.68	3.23	64.6	0.041	-3.15	0.47
-0.09	-2.68	2.59	49.1	-0.544	-3.31	0.63
-2.68	-3.28	0.60	7.8	0.079	-0.40	-2.88
-1.54	-3.28	1.74	25.7	0.105	-1.54	-1.74
0.55	-3.28	3.83	55.8	-0.392	-4.40	1.12
-3.28	-3.13	-0.15	- 0.8	-0.021	+0.09	-3.22
-2.68	-3.13	0.45	4.0	0.044	-0.35	-2.78
-1.54	-3.13	1.59	15.9	-0.005	-1.60	-1.53
0.55	-3.13	3.68	28.7	-0.747	-4.67	1.54
-2.68	-2.84	0.16	6.0	0.011	-0.13	-2.71
-1.54	-2.84	1.30	5.9	-0.065	-1.41	-1.43

[illegible]

TABLE XXIV—Continued

Lens 18

σ_1 (m)	σ_2 (m)	$\sigma_1 - \sigma_2$ (m)	DV (microns)	$\Delta X''$ (m)	$f\Delta X''/x_{s_2}$ (m)	σ_0 (m)
0.56	0	0.56	2.5	-0.028	0.04	-0.04
0.56	-0.20	0.76	2.9	0.054	-0.10	-0.10
0.33	0	0.33	2.6	-0.067	0.09	-0.09
0.33	0	0.33	3.3	-0.001	0	0
0.33	-0.20	0.53	4.7	0.052	-0.11	-0.09
0.33	-0.20	0.53	2.7	0.074	-0.21	0.01
-0.20	0	-0.20	- 2.9	0.020	-0.03	0.03
-0.20	0	-0.20	- 3.0	-0.012	0.02	-0.02
-0.20	-0.20	0	0	0	0	-0.20
-0.20	-0.15	-0.05	- 0.9	0.011	-0.01	-0.14
-0.20	0	-0.20	- 2.0	-0.003	0	0
-0.20	0	-0.20	- 3.6	-0.024	0.06	-0.06
0	-0.24	0.24	5.9	-0.042	0.06	-0.30
0	-0.15	0.15	3.7	-0.006	0.01	-0.16
0	0	0	0	0	0	0
0	-0.15	0.15	4.4	0.014	-0.03	-0.12
-0.15	0	-0.15	- 4.4	-0.014	0.12	-0.12
0	0	0	0	0	0	0
-0.15	0	-0.15	- 3.7	0.006	0.16	-0.16
-0.24	0	-0.24	- 5.9	0.042	0.30	-0.30
0	-0.20	0.20	3.6	0.024	-0.14	-0.06
0	-0.20	0.20	2.0	0.003	-0.21	0.01
-0.15	-0.20	0.05	0.9	-0.011	-0.01	-0.13
-0.20	-0.20	0	0	0	0	-0.20
0	-0.20	0.20	3.0	0.012	-0.18	-0.02
0	-0.20	0.20	2.9	-0.020	-0.22	0.02
-0.20	0.33	-0.53	- 2.7	-0.074	0.33	0
-0.20	0.33	-0.53	- 4.7	-0.052	0.42	-0.09
0	0.33	-0.33	- 3.3	0.001	0.32	0.01
0	0.33	-0.33	- 2.6	0.067	0.42	-0.09
-0.20	0.56	-0.76	- 2.9	-0.054	0.66	-0.10
0	0.56	-0.56	- 2.5	0.028	0.61	-0.05

TABLE XXIV--Continued

Average						
θ_1	θ_2	$\theta_1 - \theta_2$	ρ_V	$\Delta X''$	$f\Delta X''/\pi_{\theta_2}$	θ_0
(m)	(m)	(m)	(microns)	(m)	(m)	(m)
-0.54	-0.02	-0.52	- 2.4	0.026	-0.04	0.02
-0.54	-0.55	0.01	0	0.001	0	-0.55
-0.58	+0.27	-0.85	- 6.6	0.173	-0.23	0.50
-0.58	-0.02	-0.56	- 5.6	0.002	0	-0.02
-0.58	-0.55	-0.03	- 0.3	-0.003	+0.01	-0.56
-0.58	-0.80	0.22	1.1	0.031	-0.08	-0.72
-0.80	0.27	-1.07	-15.6	0.110	-0.16	0.43
-0.80	-0.02	-0.78	-11.5	-0.047	+0.09	-0.11
-0.80	-0.55	-0.25	- 3.2	-0.033	+0.08	-0.63
-0.55	-0.12	-0.43	- 8.1	0.091	-0.12	0
-0.55	0.27	-0.82	-16.4	-0.010	+0.02	0.24
-0.55	-0.02	-0.53	-10.1	-0.064	+0.15	-0.17
-0.02	-0.32	0.30	7.3	-0.053	+0.07	-0.39
-0.02	-0.12	0.10	2.5	-0.004	+0.01	-0.13
-0.02	0.27	-0.29	- 4.7	-0.031	+0.07	0.20
0.27	-0.12	0.39	11.6	0.036	-0.08	-0.04
-0.12	0.27	-0.39	-11.6	-0.036	+0.31	-0.04
0.27	-0.02	0.29	4.7	0.031	-0.22	0.20
-0.12	-0.02	-0.10	- 2.5	0.004	+0.11	-0.13
-0.32	-0.02	-0.30	- 7.3	0.053	+0.37	-0.39
-0.02	-0.55	0.53	10.1	0.064	-0.38	-0.17
0.27	-0.55	0.82	16.4	0.010	-0.77	0.22
-0.12	-0.55	0.43	8.1	-0.091	-0.55	0
-0.55	-0.80	0.25	3.2	0.033	-0.17	-0.63
-0.02	-0.80	0.78	11.5	0.047	-0.69	-0.11
0.27	-0.80	1.07	15.6	-0.110	-1.23	0.43
-0.80	-0.58	-0.22	- 1.1	-0.031	+0.14	-0.72
-0.55	-0.58	0.03	0.3	0.003	-0.02	-0.56
-0.02	-0.58	0.56	5.6	-0.002	-0.61	0.03
0.27	-0.58	0.85	6.6	-0.173	-1.08	0.50
-0.55	-0.54	-0.01	0	-0.001	+0.01	-0.55
-0.02	-0.54	0.52	2.4	-0.026	-0.56	0.02

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868	2869	2870	2871	2872	2873	2874	2875	2876	2877	2878	2879	2880	2881	2882	2883	2884	2885	2886	2887	2888	2889	2890	2891	2892	2893	2894	2895	2896	2897	2898	2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2909	2910	2911	2912	2913	2914	2915	2916	2917	2918	2919	2920	2921	2922	2923	2924	2925	2926	2927	2928	2929	2930	2931	2932	2933	2934	2935	2936	2937	2938	2939	2940	2941	2942	2943	2944	2945	2946	2947	2948	2949	2950	2951	2952	2953	2954	2955	2956	2957	2958	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E1

Figure 12

Y-Parallax in microns

Stereo model formed with Lens #13

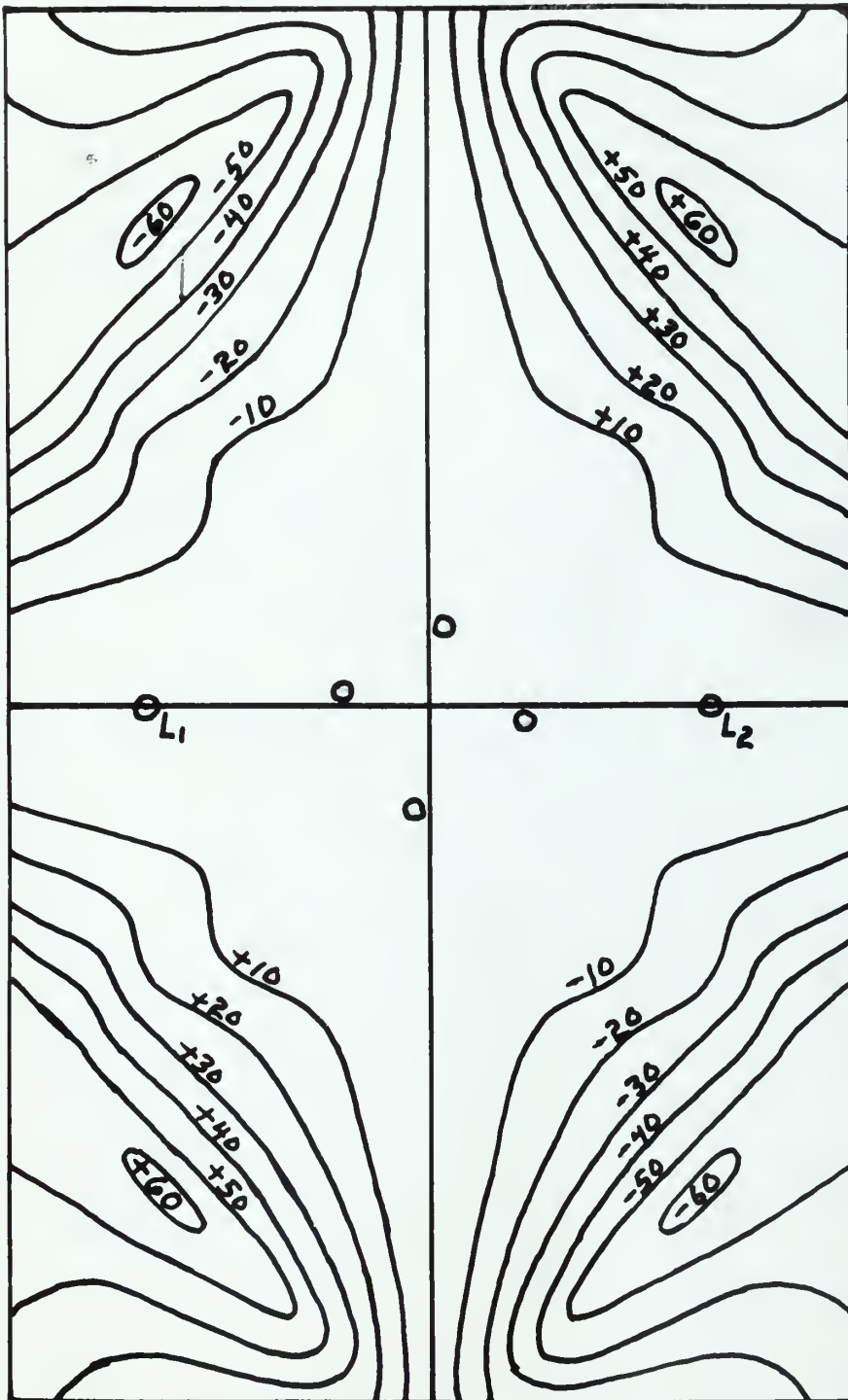


Figure 1

Y-Parallax in microns
Stereo model formed with Average Lens

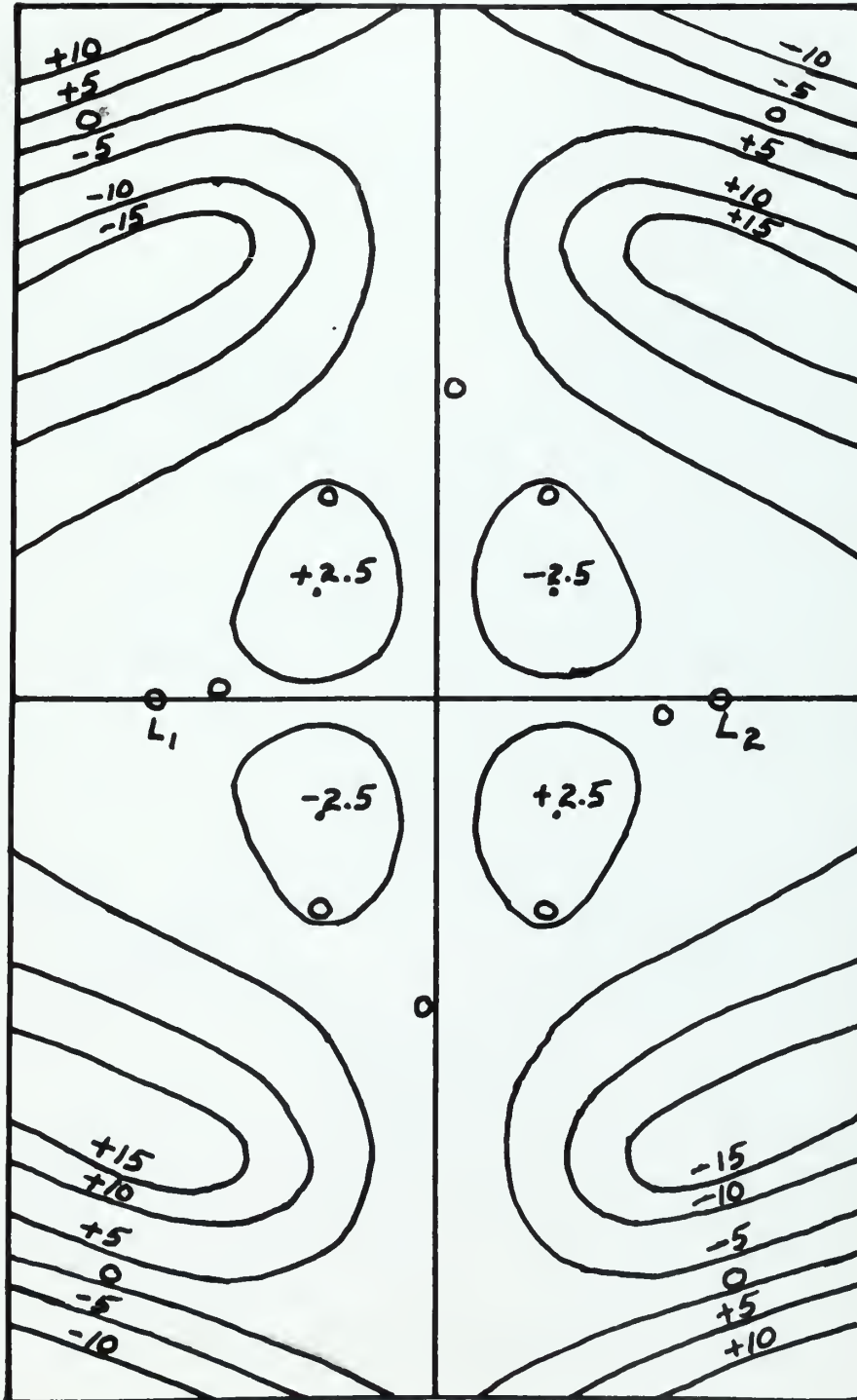
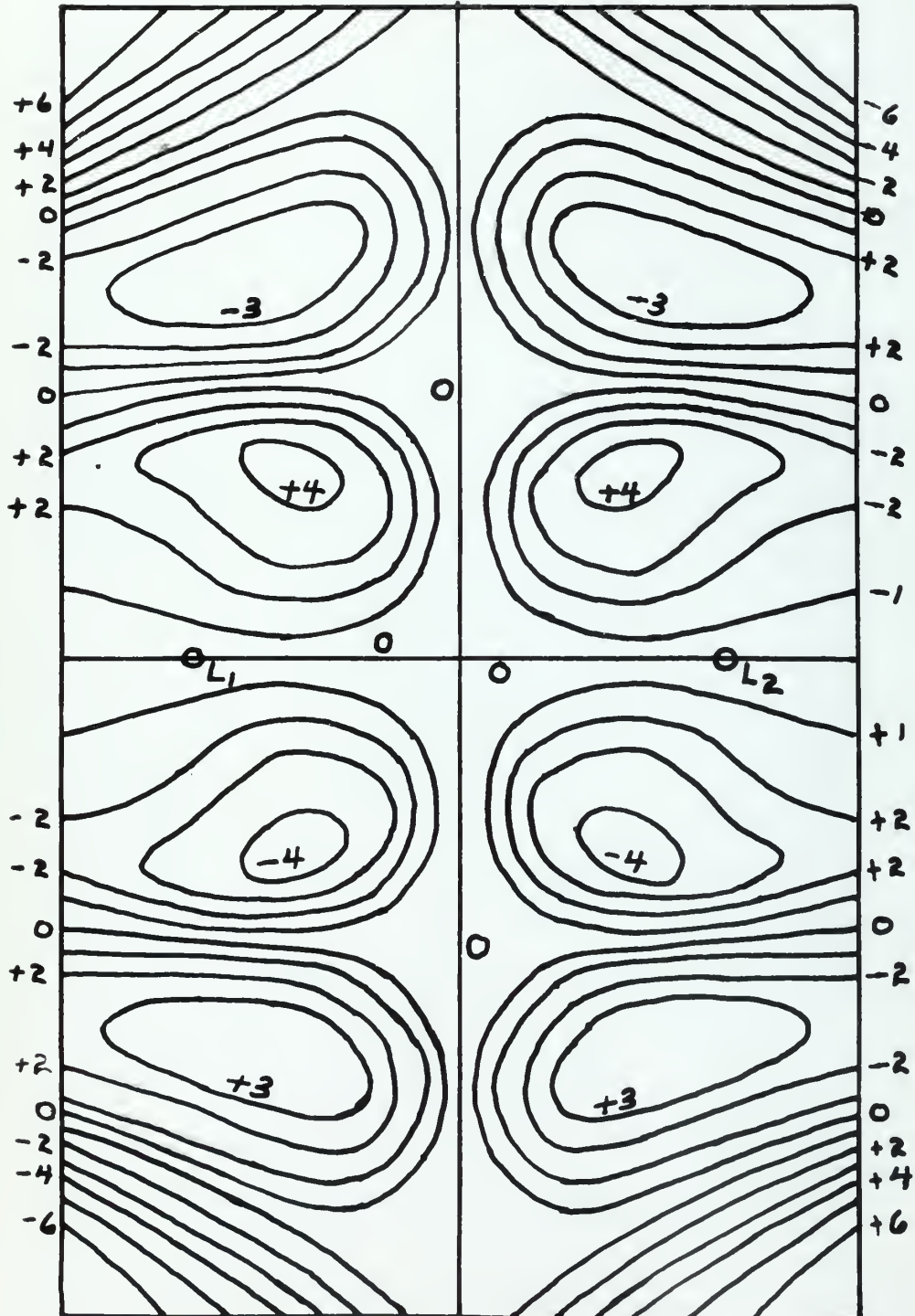


Figure 14

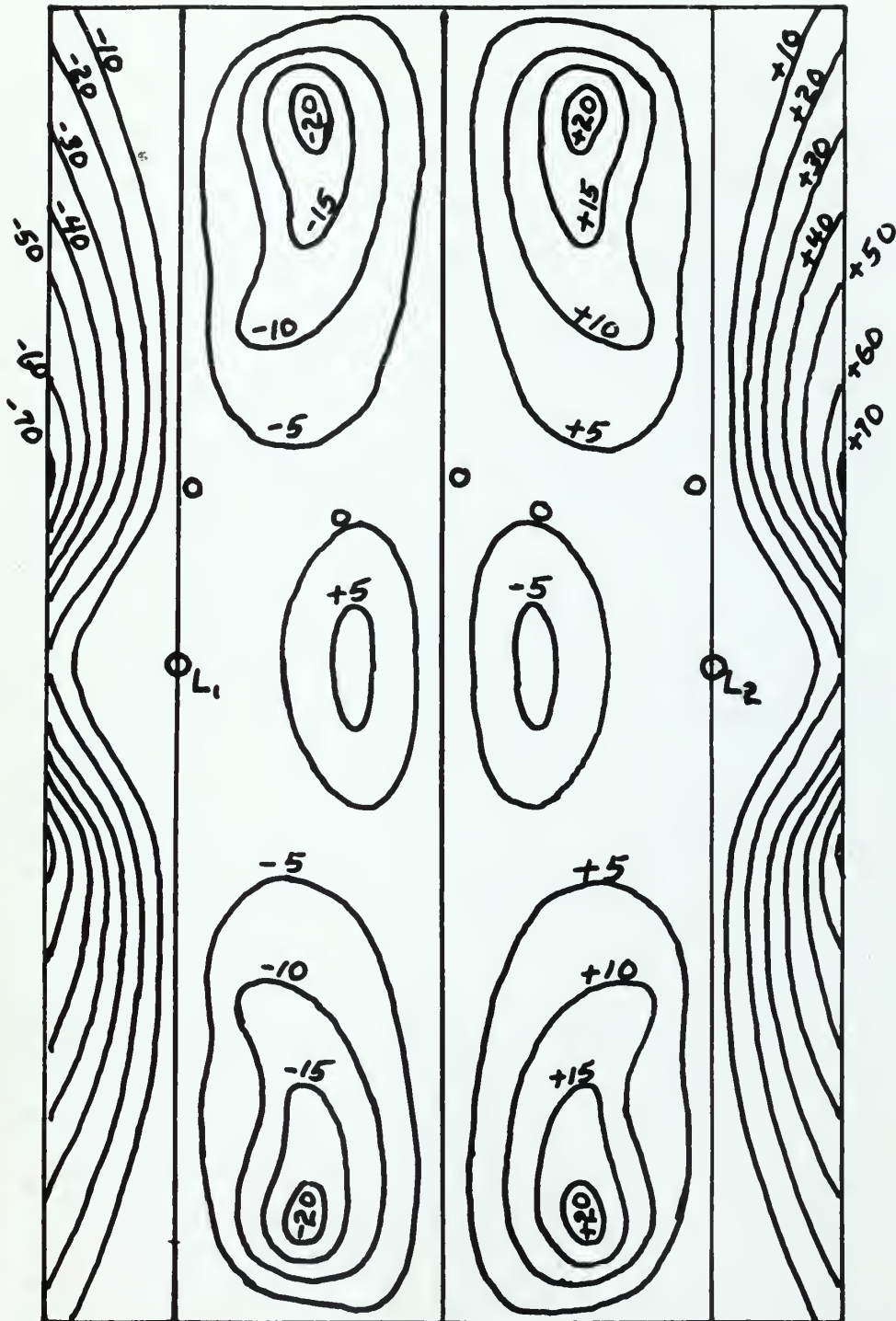
Y-parallax in microns

Stereo model formed with Lens #18



X-direction errors in centimeters
Stereo model formed with Lens #13

Figure 15



X-direction errors in centimeters
Stereo model formed with Average Lens

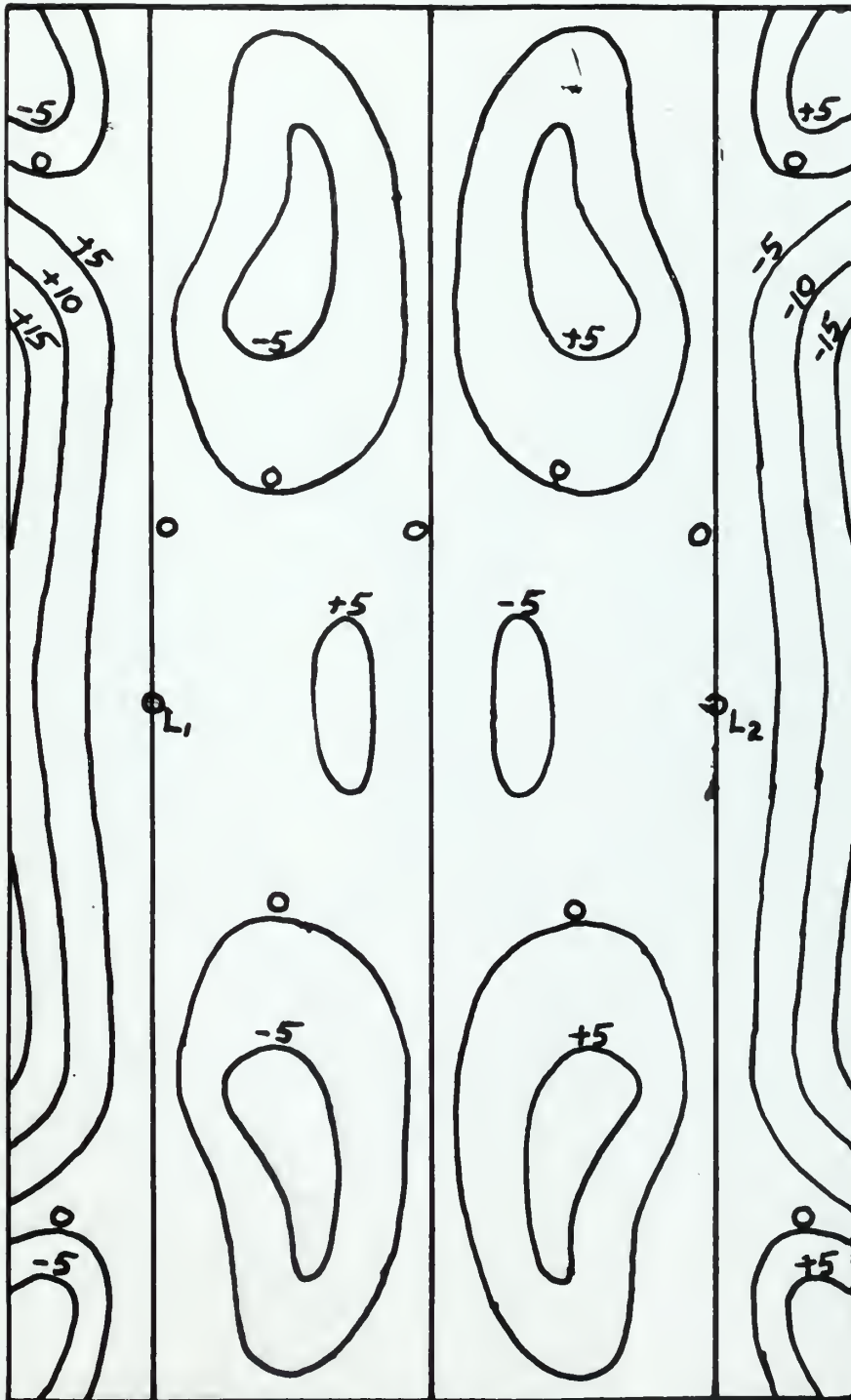
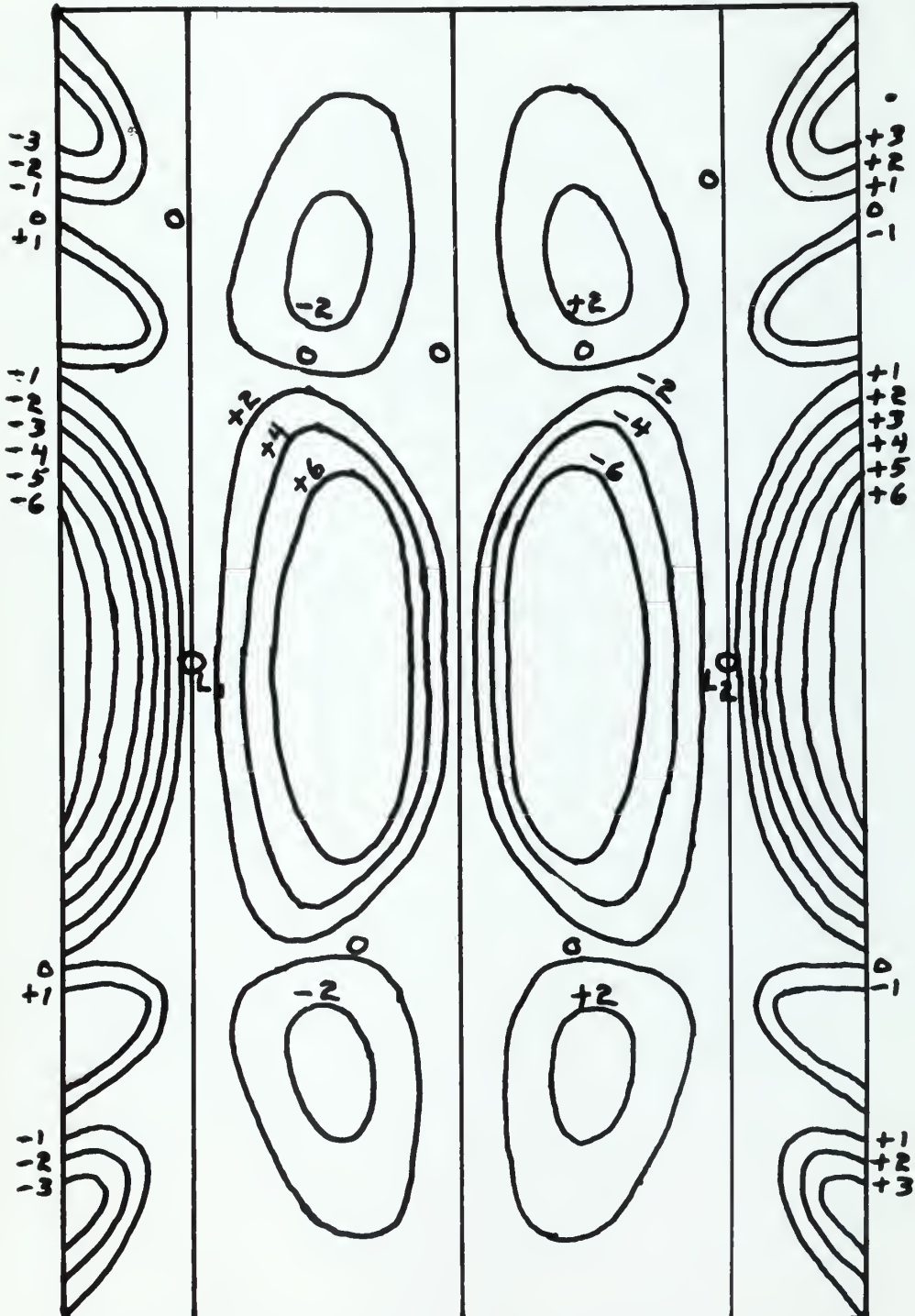
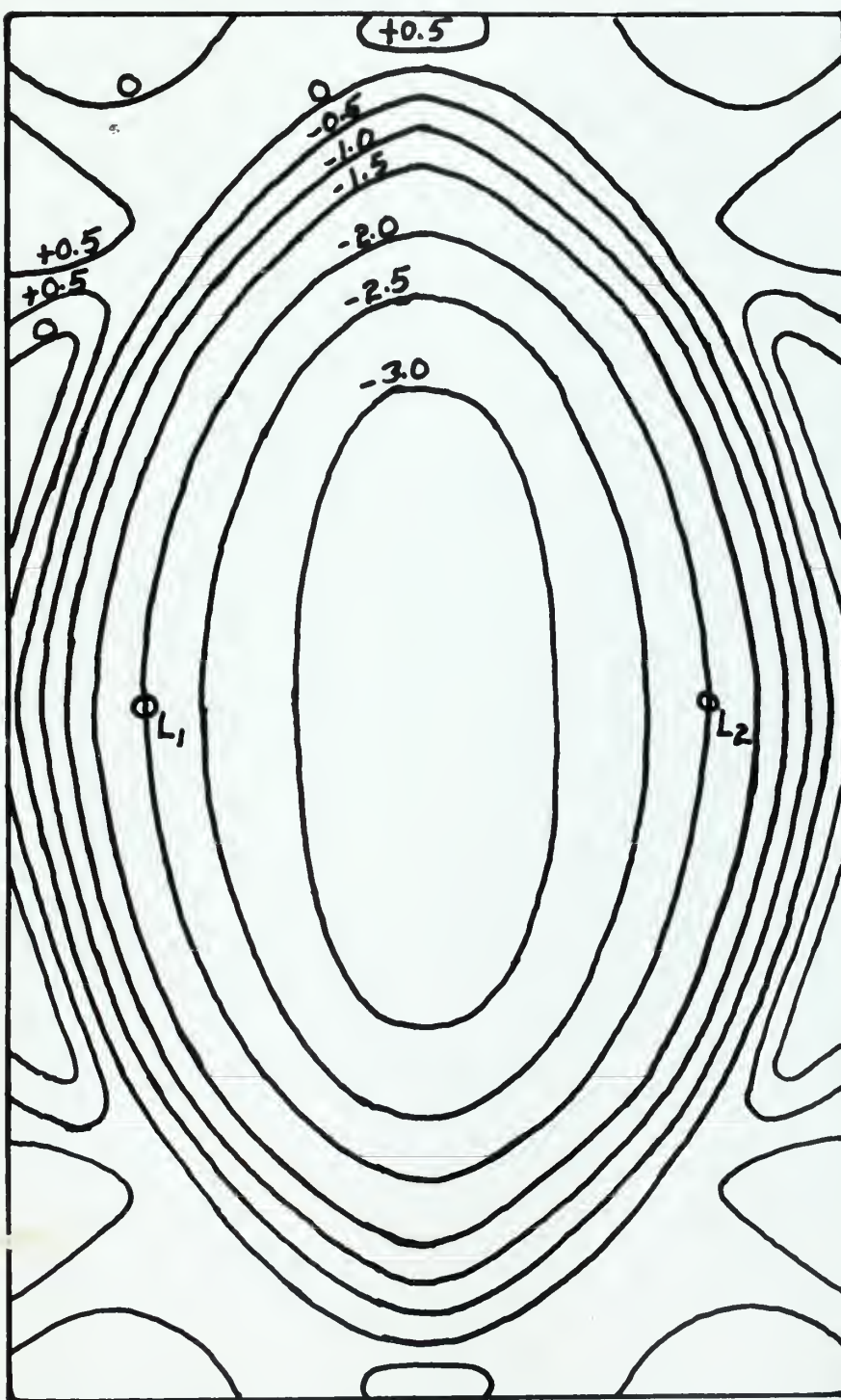


Figure 17

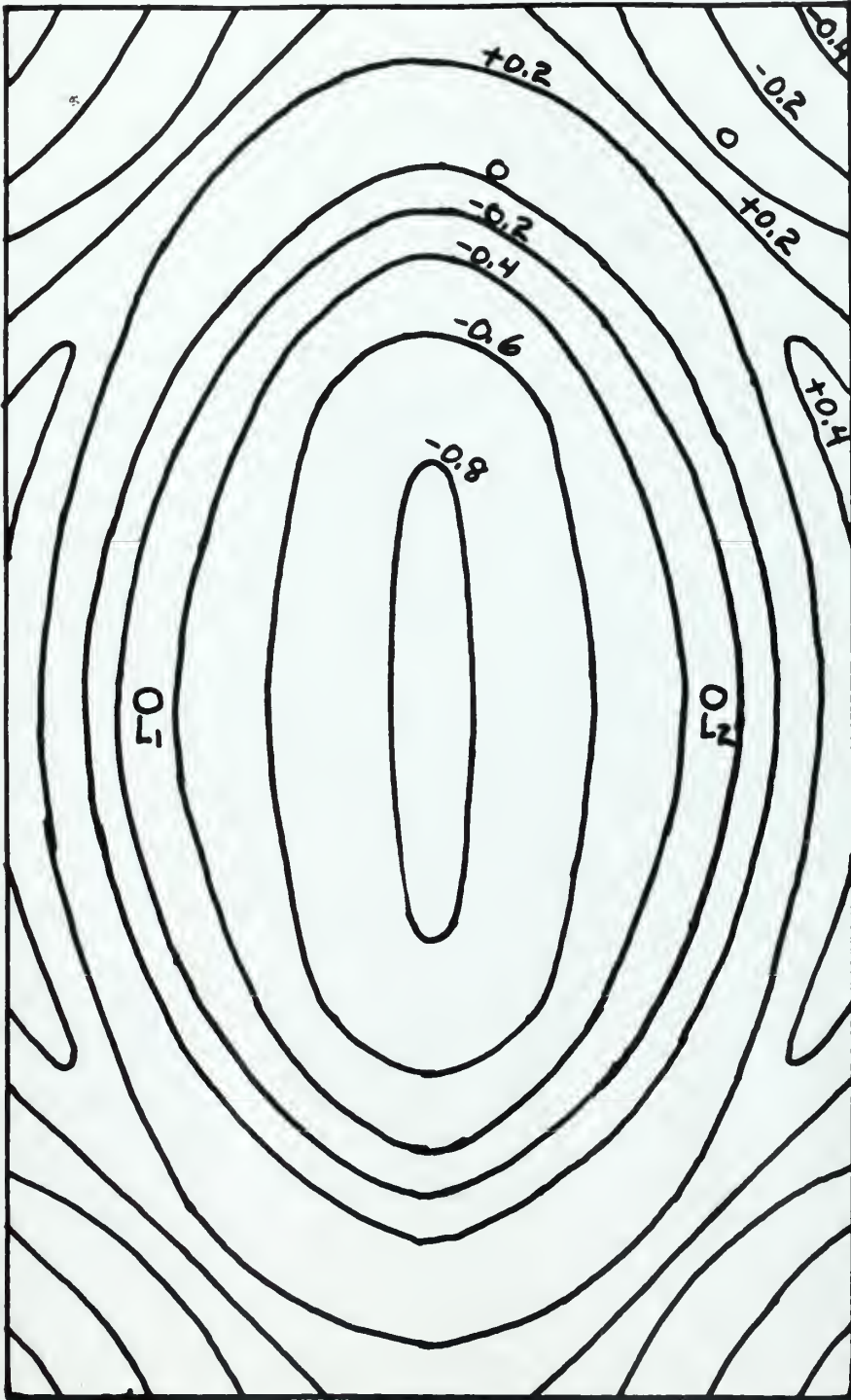
λ -direction errors in centimeters
Stereo model formed with Lens #18



Elevation errors in meters
Stereo model formed with Lens #13



Elevation errors in meters
Stereo model formed with Average Lens



Elevation errors in meters
Stereo model formed with Lens #18

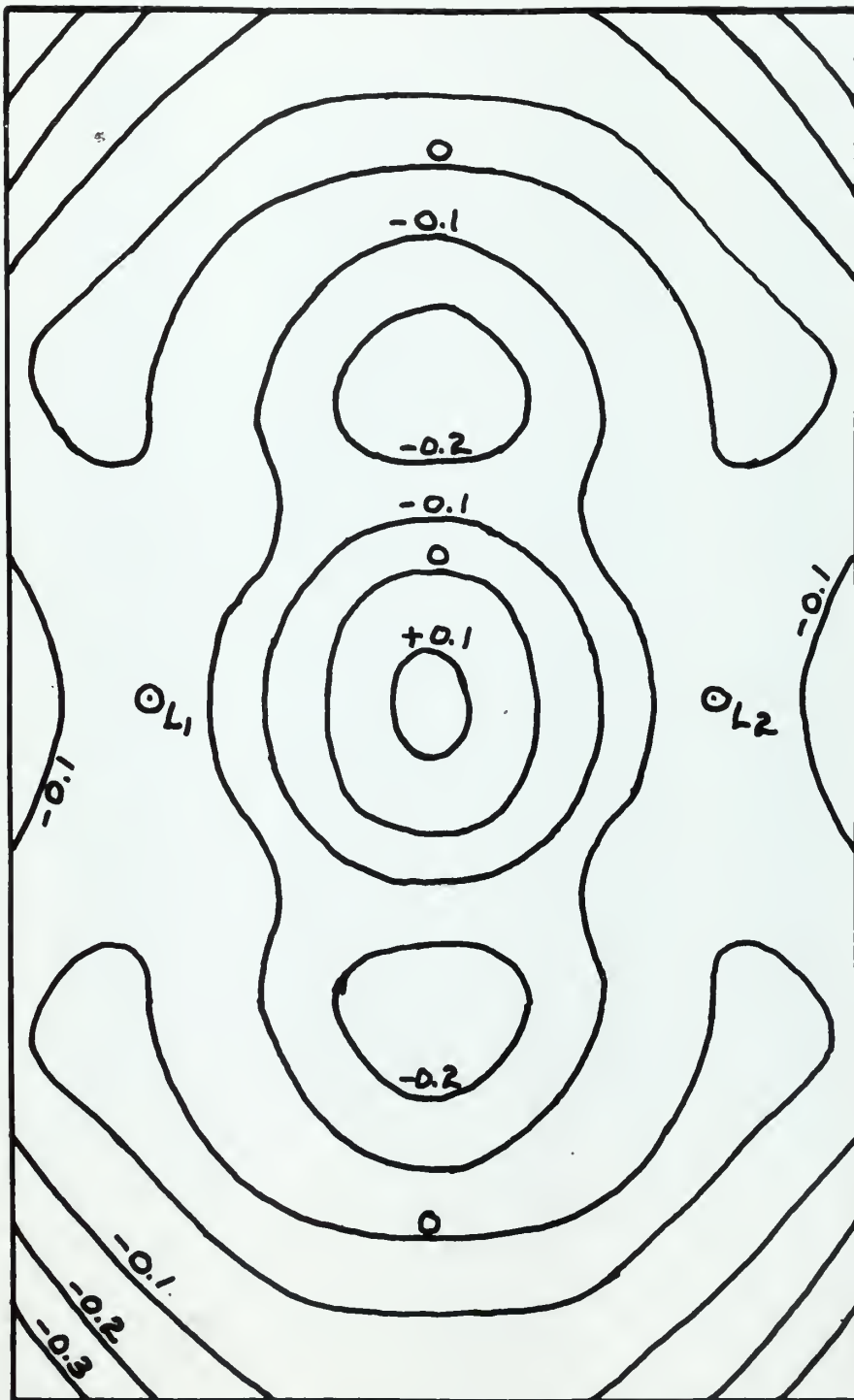


TABLE XXV

x	$(x - b)$	$\frac{(x - b)^2}{b}$	$2 + 4$	$\frac{x - b}{b}$
(cm)	(mm)	(mm)	(mm)	(mm)
- 9.85	-189.9	394.555	648.566	-2.0777
- 7.88	-170.2	316.929	570.940	-1.8621
-11.60	-207.4	470.611	724.622	-2.2691
- 9.19	-183.3	367.608	621.619	-2.0055
- 7.22	-163.6	292.828	546.839	-1.7899
- 5.65	-147.9	239.332	493.343	-1.6182
-10.51	-196.5	422.455	676.466	-2.1499
- 8.09	-172.3	324.803	578.814	-1.8851
- 6.34	-152.8	255.451	509.462	-1.6718
-11.67	-208.1	473.802	727.813	-2.2768
- 8.94	-180.8	357.640	611.651	-1.9781
- 6.55	-156.9	269.335	523.346	-1.7166
-11.32	-204.6	457.997	712.008	-2.2385
- 9.70	-188.4	388.349	642.360	-2.0613
- 7.00	-161.4	285.016	539.027	-1.7659
- 7.36	-165.0	297.875	551.886	-1.8053
-1.78	-109.2	139.461	384.472	-1.1947
-2.14	-112.8	139.206	393.217	-1.2341
0.56	- 85.8	80.540	334.551	-0.9387
2.18	- 69.6	53.000	307.011	-0.7615
-2.59	-117.3	150.543	404.554	-1.2834
-0.20	- 93.4	95.445	349.456	-1.0219
2.53	- 66.1	46.429	300.440	-0.7024
-3.00	-121.4	162.243	425.254	-1.3282
-1.05	-101.9	113.608	367.619	-1.1149
1.37	- 77.7	66.053	320.064	-0.8501
-3.49	-126.3	174.521	428.532	-1.3818
-1.92	-110.6	133.837	387.848	-1.2161
0.05	- 90.9	90.400	344.411	-0.9945
2.46	- 66.8	48.824	302.835	-0.7309
-1.26	-104.0	118.342	372.353	-1.1379
0.71	- 84.3	77.750	331.761	-0.9223

TABLE 1

$\lambda - \mu$ (mm)	$\lambda + \mu$ (mm)	$\frac{\lambda - \mu}{\lambda + \mu}$ (mm)	$\lambda - \mu$ (mm)	μ (mm)
1170.0	332.550	232.400	2.000	1170.0
1180.0	332.550	232.400	2.000	1180.0
1190.0	332.550	232.400	2.000	1190.0
1200.0	332.550	232.400	2.000	1200.0
1210.0	332.550	232.400	2.000	1210.0
1220.0	332.550	232.400	2.000	1220.0
1230.0	332.550	232.400	2.000	1230.0
1240.0	332.550	232.400	2.000	1240.0
1250.0	332.550	232.400	2.000	1250.0
1260.0	332.550	232.400	2.000	1260.0
1270.0	332.550	232.400	2.000	1270.0
1280.0	332.550	232.400	2.000	1280.0
1290.0	332.550	232.400	2.000	1290.0
1300.0	332.550	232.400	2.000	1300.0
1310.0	332.550	232.400	2.000	1310.0
1320.0	332.550	232.400	2.000	1320.0
1330.0	332.550	232.400	2.000	1330.0
1340.0	332.550	232.400	2.000	1340.0
1350.0	332.550	232.400	2.000	1350.0
1360.0	332.550	232.400	2.000	1360.0
1370.0	332.550	232.400	2.000	1370.0
1380.0	332.550	232.400	2.000	1380.0
1390.0	332.550	232.400	2.000	1390.0
1400.0	332.550	232.400	2.000	1400.0
1410.0	332.550	232.400	2.000	1410.0
1420.0	332.550	232.400	2.000	1420.0
1430.0	332.550	232.400	2.000	1430.0
1440.0	332.550	232.400	2.000	1440.0
1450.0	332.550	232.400	2.000	1450.0
1460.0	332.550	232.400	2.000	1460.0
1470.0	332.550	232.400	2.000	1470.0
1480.0	332.550	232.400	2.000	1480.0
1490.0	332.550	232.400	2.000	1490.0
1500.0	332.550	232.400	2.000	1500.0
1510.0	332.550	232.400	2.000	1510.0
1520.0	332.550	232.400	2.000	1520.0
1530.0	332.550	232.400	2.000	1530.0
1540.0	332.550	232.400	2.000	1540.0
1550.0	332.550	232.400	2.000	1550.0
1560.0	332.550	232.400	2.000	1560.0
1570.0	332.550	232.400	2.000	1570.0
1580.0	332.550	232.400	2.000	1580.0
1590.0	332.550	232.400	2.000	1590.0
1600.0	332.550	232.400	2.000	1600.0
1610.0	332.550	232.400	2.000	1610.0
1620.0	332.550	232.400	2.000	1620.0
1630.0	332.550	232.400	2.000	1630.0
1640.0	332.550	232.400	2.000	1640.0
1650.0	332.550	232.400	2.000	1650.0
1660.0	332.550	232.400	2.000	1660.0
1670.0	332.550	232.400	2.000	1670.0
1680.0	332.550	232.400	2.000	1680.0
1690.0	332.550	232.400	2.000	1690.0
1700.0	332.550	232.400	2.000	1700.0
1710.0	332.550	232.400	2.000	1710.0
1720.0	332.550	232.400	2.000	1720.0
1730.0	332.550	232.400	2.000	1730.0
1740.0	332.550	232.400	2.000	1740.0
1750.0	332.550	232.400	2.000	1750.0
1760.0	332.550	232.400	2.000	1760.0
1770.0	332.550	232.400	2.000	1770.0
1780.0	332.550	232.400	2.000	1780.0
1790.0	332.550	232.400	2.000	1790.0
1800.0	332.550	232.400	2.000	1800.0
1810.0	332.550	232.400	2.000	1810.0
1820.0	332.550	232.400	2.000	1820.0
1830.0	332.550	232.400	2.000	1830.0
1840.0	332.550	232.400	2.000	1840.0
1850.0	332.550	232.400	2.000	1850.0
1860.0	332.550	232.400	2.000	1860.0
1870.0	332.550	232.400	2.000	1870.0
1880.0	332.550	232.400	2.000	1880.0
1890.0	332.550	232.400	2.000	1890.0
1900.0	332.550	232.400	2.000	1900.0
1910.0	332.550	232.400	2.000	1910.0
1920.0	332.550	232.400	2.000	1920.0
1930.0	332.550	232.400	2.000	1930.0
1940.0	332.550	232.400	2.000	1940.0
1950.0	332.550	232.400	2.000	1950.0
1960.0	332.550	232.400	2.000	1960.0
1970.0	332.550	232.400	2.000	1970.0
1980.0	332.550	232.400	2.000	1980.0
1990.0	332.550	232.400	2.000	1990.0
2000.0	332.550	232.400	2.000	2000.0

TABLE XIV--Continued

Lens 13 dh (m)	Ave. Lens dh (m)	Lens 18 dh (m)	Lens 13 σ^2 (m)	Ave. Lens σ^2 (m)	Lens 18 σ^2 (m)
-18.00	1.22	2.05	16.46	-1.24	-2.05
-15.80	1.07	1.80	13.12	-1.62	-2.00
-20.19	1.37	2.30	19.64	-1.10	-2.30
-17.23	1.17	1.96	15.69	-1.19	-1.96
-15.12	1.02	1.72	12.44	-1.57	-1.92
-13.64	0.92	1.55	10.36	-1.72	-1.75
-18.80	1.27	2.14	18.25	-1.00	-2.14
-16.02	1.08	1.82	14.48	-1.10	-1.82
-14.08	0.95	1.60	11.40	-1.50	-1.80
-20.22	1.37	2.31	20.19	-1.49	-2.46
-16.94	1.15	1.93	16.39	-0.88	-1.93
-14.46	0.98	1.65	12.92	-1.00	-1.65
-19.82	1.34	2.26	19.63	-1.66	-2.50
-17.82	1.21	2.03	17.73	-1.33	-2.18
-14.90	1.01	1.70	14.35	-0.74	-1.70
-15.26	1.03	1.74	15.17	-1.15	-1.89
-10.72	0.73	1.22	10.17	-0.46	-1.22
-10.95	0.74	1.25	9.41	-0.76	-1.25
- 9.48	0.64	1.08	7.94	-0.66	-1.08
- 8.85	0.60	1.01	7.31	-0.62	-1.01
-11.25	0.76	1.28	8.57	-1.15	-1.48
- 9.84	0.67	1.12	7.16	-1.22	-1.32
- 8.72	0.59	0.99	6.04	-1.14	-1.19
-11.53	0.78	1.31	8.25	-1.58	-0.98
-10.30	0.70	1.17	7.02	-1.50	-1.37
- 9.14	0.62	1.04	5.86	-1.42	-1.24
-11.88	0.80	1.35	8.75	-1.38	-1.02
-10.81	0.73	1.23	7.68	-1.31	-0.90
- 9.72	0.67	1.11	6.59	-1.25	-0.78
- 8.76	0.59	1.00	5.63	-1.17	-0.67
-10.41	0.71	1.19	7.57	-1.25	-0.63
- 9.42	0.73	1.07	6.58	-1.27	-0.51

[illegible]

TABLE XXVI

x_{a1} (cm)	x_{a2} (cm)	y_a (cm)
-0.71	- 9.85	1.82
1.26	- 7.88	1.51
-2.46	-11.60	3.12
-0.05	- 9.19	4.00
1.92	- 7.22	3.52
3.49	- 5.65	2.00
-1.37	-10.51	5.83
1.05	- 8.09	5.90
3.00	- 6.14	5.19
-2.53	-11.67	7.58
0.20	- 8.94	8.00
2.59	- 6.55	7.59
-2.18	-11.32	9.77
-0.56	- 9.70	9.99
2.14	- 7.00	9.89
1.78	- 7.36	11.85
7.36	- 1.78	11.85
7.00	-2.14	9.89
9.70	0.56	9.99
11.32	2.18	9.77
6.55	- 2.59	7.59
8.94	- 0.20	8.00
11.67	2.53	7.58
6.14	- 3.00	5.19
8.09	- 1.05	5.90
10.51	1.37	5.83
5.65	- 3.49	2.00
7.22	-1.92	3.52
9.19	0.05	4.00
11.60	2.46	3.12
7.88	- 1.26	1.51
9.85	0.71	1.82

Date	α° (m)	β° (m)	γ° (m)	Time
19.1	23.1	28.0	22.0	19.1
20.1	23.1	28.0	22.0	19.1
21.1	23.1	28.0	22.0	19.1
22.1	23.1	28.0	22.0	19.1
23.1	23.1	28.0	22.0	19.1
24.1	23.1	28.0	22.0	19.1
25.1	23.1	28.0	22.0	19.1
26.1	23.1	28.0	22.0	19.1
27.1	23.1	28.0	22.0	19.1
28.1	23.1	28.0	22.0	19.1
29.1	23.1	28.0	22.0	19.1
30.1	23.1	28.0	22.0	19.1
31.1	23.1	28.0	22.0	19.1
32.1	23.1	28.0	22.0	19.1
33.1	23.1	28.0	22.0	19.1
34.1	23.1	28.0	22.0	19.1
35.1	23.1	28.0	22.0	19.1
36.1	23.1	28.0	22.0	19.1
37.1	23.1	28.0	22.0	19.1
38.1	23.1	28.0	22.0	19.1
39.1	23.1	28.0	22.0	19.1
40.1	23.1	28.0	22.0	19.1
41.1	23.1	28.0	22.0	19.1
42.1	23.1	28.0	22.0	19.1
43.1	23.1	28.0	22.0	19.1
44.1	23.1	28.0	22.0	19.1
45.1	23.1	28.0	22.0	19.1

TABLE XXVI—Continued

Lens 13						
θ_1	θ_2	$\theta_1 - \theta_2$	ν	$\Delta X''$	$f \Delta X'' / x_{a2}$	θ_0
(m)	(m)	(m)	(microns)	(m)	(m)	(m)
-2.84	16.46	-19.30	- 87.8	0.961	-1.50	17.96
-2.84	13.12	-15.96	- 60.2	-1.128	2.20	10.92
-3.13	19.64	-22.77	-177.6	4.624	-6.13	25.77
-3.13	15.69	-18.82	-168.2	0.062	-0.10	15.79
-3.13	12.44	-15.57	-137.1	-1.536	3.27	9.17
-3.13	10.36	-13.49	- 67.5	-1.893	5.15	5.21
-3.28	18.25	-21.53	-313.8	2.206	-3.23	21.48
-3.28	14.48	-17.76	-261.9	-1.074	2.04	12.44
-3.28	11.40	-14.68	-190.5	-1.924	4.82	6.58
-2.68	20.19	-22.87	-433.4	4.805	-1.53	21.72
-2.68	16.39	-19.07	-381.4	-0.243	0.42	15.97
-2.68	12.92	-15.60	-296.0	-1.883	4.42	8.50
-1.54	19.63	-21.17	-517.1	3.718	-5.05	24.68
-1.54	17.73	-19.27	-481.3	0.745	-1.18	18.91
-1.54	14.35	-15.89	-392.9	-1.694	3.72	10.63
0.55	15.17	-15.72	-465.7	-1.465	3.06	12.11
-0.09	10.17	-10.26	-303.9	-0.956	8.26	1.91
0.55	9.41	- 8.86	-219.1	-0.944	6.78	2.63
-0.09	7.94	- 8.03	-200.5	0.310	8.51	-0.57
0.19	7.31	- 7.12	-173.9	1.250	8.82	-1.51
-1.54	8.57	-10.11	-191.8	-1.220	7.24	1.33
0.55	7.16	- 6.61	-132.2	-0.084	6.46	0.70
-0.09	6.04	- 6.13	-116.2	1.288	7.83	-1.79
-2.68	8.25	-10.93	-141.8	-1.433	7.34	0.91
-1.54	7.02	- 8.56	-126.3	-0.517	7.57	-0.55
0.55	5.86	- 5.31	- 77.4	0.544	6.11	-0.25
-3.28	8.75	-12.03	- 60.2	-1.688	7.44	1.31
-2.68	7.68	-10.36	- 91.2	-1.022	8.16	-0.50
-1.54	6.59	- 8.13	- 81.3	0.027	8.30	-1.71
0.55	5.63	- 5.08	- 39.6	1.032	6.45	-0.82
-2.68	7.57	-10.25	- 38.7	-0.724	8.83	-1.26
-1.54	6.58	- 8.12	- 36.9	0.404	8.75	-2.17

[illegible]

TABLE XXVI—Continued

Lens 18						
ϕ_1	ϕ_2	$\phi_1 - \phi_2$	DV	dX''	$f dX'' / z_{a2}$	e_o
(m)	(m)	(m)	(microns)	(m)	(m)	(m)
0.56	-2.05	2.61	11.9	-0.130	0.20	-2.25
0.56	-2.00	2.56	9.7	0.181	-0.35	-1.65
0.33	-2.30	2.63	20.5	-0.534	0.71	-3.01
0.33	-1.96	2.29	22.9	-0.007	0.01	-1.97
0.33	-1.92	2.15	18.9	0.212	-0.45	-1.47
0.33	-1.75	2.08	10.4	0.292	-0.79	-0.96
0.20	-2.14	2.34	34.1	-0.240	0.35	-2.49
0.20	-1.82	2.02	29.8	0.122	-0.23	-1.59
0.20	-1.80	2.00	26.0	0.262	-0.66	-1.14
0.20	-2.46	2.66	50.4	-0.559	0.74	-3.20
0.20	-1.93	2.13	42.6	0.027	-0.05	-1.88
0.20	-1.65	1.85	35.1	0.223	-0.52	-1.13
0	-2.50	2.50	61.1	-0.439	0.60	-3.10
0	-2.18	2.18	54.4	-0.084	0.13	-2.31
0	-1.70	1.70	42.0	0.184	-0.40	-1.30
0	-1.89	1.89	56.0	0.176	-0.37	-1.52
-0.15	-1.22	1.07	31.7	0.100	-0.86	-0.36
0	-1.25	1.25	30.9	0.133	-0.95	-0.30
-0.15	-1.08	0.93	23.2	-0.036	-0.99	-0.09
-0.24	-1.01	0.77	18.8	-0.135	-0.95	-0.06
0	-1.48	1.48	28.1	0.179	-1.06	-0.42
0	-1.32	1.32	26.4	0.017	-1.31	-0.01
-0.15	-1.19	1.04	19.7	-0.219	-1.33	0.14
-0.20	-0.98	0.78	10.1	0.102	-0.52	-0.46
0	-1.37	1.37	20.2	0.083	-1.21	-0.16
0	-1.24	1.24	18.1	-0.127	-1.42	0.18
-0.20	-1.02	0.82	4.1	0.115	-0.51	-0.51
-0.20	-0.90	0.70	6.2	0.069	-0.55	-0.35
0	-0.78	0.78	7.8	-0.003	-0.92	0.14
0	-0.67	0.67	5.2	-0.136	-0.85	0.18
-0.20	-0.63	0.43	1.6	0.030	-0.37	-0.26
0	-0.51	0.51	2.3	-0.001	-0.02	-0.49

EXPERIMENTAL DATA

42 mm						
λ	λ_{vac}	λ_{air}	λ_{eff}	λ_{eff}	λ_{eff}	λ_{eff}
(μ)	(μ)	(μ)	(microns)	(μ)	(μ)	(μ)
4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.1	4.1	4.1	4.1	4.1	4.1	4.1
4.2	4.2	4.2	4.2	4.2	4.2	4.2
4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.4	4.4	4.4	4.4	4.4	4.4	4.4
4.5	4.5	4.5	4.5	4.5	4.5	4.5
4.6	4.6	4.6	4.6	4.6	4.6	4.6
4.7	4.7	4.7	4.7	4.7	4.7	4.7
4.8	4.8	4.8	4.8	4.8	4.8	4.8
4.9	4.9	4.9	4.9	4.9	4.9	4.9
5.0	5.0	5.0	5.0	5.0	5.0	5.0
5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.2	5.2	5.2	5.2	5.2	5.2	5.2
5.3	5.3	5.3	5.3	5.3	5.3	5.3
5.4	5.4	5.4	5.4	5.4	5.4	5.4
5.5	5.5	5.5	5.5	5.5	5.5	5.5
5.6	5.6	5.6	5.6	5.6	5.6	5.6
5.7	5.7	5.7	5.7	5.7	5.7	5.7
5.8	5.8	5.8	5.8	5.8	5.8	5.8
5.9	5.9	5.9	5.9	5.9	5.9	5.9
6.0	6.0	6.0	6.0	6.0	6.0	6.0
6.1	6.1	6.1	6.1	6.1	6.1	6.1
6.2	6.2	6.2	6.2	6.2	6.2	6.2
6.3	6.3	6.3	6.3	6.3	6.3	6.3
6.4	6.4	6.4	6.4	6.4	6.4	6.4
6.5	6.5	6.5	6.5	6.5	6.5	6.5
6.6	6.6	6.6	6.6	6.6	6.6	6.6
6.7	6.7	6.7	6.7	6.7	6.7	6.7
6.8	6.8	6.8	6.8	6.8	6.8	6.8
6.9	6.9	6.9	6.9	6.9	6.9	6.9
7.0	7.0	7.0	7.0	7.0	7.0	7.0
7.1	7.1	7.1	7.1	7.1	7.1	7.1
7.2	7.2	7.2	7.2	7.2	7.2	7.2
7.3	7.3	7.3	7.3	7.3	7.3	7.3
7.4	7.4	7.4	7.4	7.4	7.4	7.4
7.5	7.5	7.5	7.5	7.5	7.5	7.5
7.6	7.6	7.6	7.6	7.6	7.6	7.6
7.7	7.7	7.7	7.7	7.7	7.7	7.7
7.8	7.8	7.8	7.8	7.8	7.8	7.8
7.9	7.9	7.9	7.9	7.9	7.9	7.9
8.0	8.0	8.0	8.0	8.0	8.0	8.0
8.1	8.1	8.1	8.1	8.1	8.1	8.1
8.2	8.2	8.2	8.2	8.2	8.2	8.2
8.3	8.3	8.3	8.3	8.3	8.3	8.3
8.4	8.4	8.4	8.4	8.4	8.4	8.4
8.5	8.5	8.5	8.5	8.5	8.5	8.5
8.6	8.6	8.6	8.6	8.6	8.6	8.6
8.7	8.7	8.7	8.7	8.7	8.7	8.7
8.8	8.8	8.8	8.8	8.8	8.8	8.8
8.9	8.9	8.9	8.9	8.9	8.9	8.9
9.0	9.0	9.0	9.0	9.0	9.0	9.0
9.1	9.1	9.1	9.1	9.1	9.1	9.1
9.2	9.2	9.2	9.2	9.2	9.2	9.2
9.3	9.3	9.3	9.3	9.3	9.3	9.3
9.4	9.4	9.4	9.4	9.4	9.4	9.4
9.5	9.5	9.5	9.5	9.5	9.5	9.5
9.6	9.6	9.6	9.6	9.6	9.6	9.6
9.7	9.7	9.7	9.7	9.7	9.7	9.7
9.8	9.8	9.8	9.8	9.8	9.8	9.8
9.9	9.9	9.9	9.9	9.9	9.9	9.9
10.0	10.0	10.0	10.0	10.0	10.0	10.0

TABLE XXVI—Continued

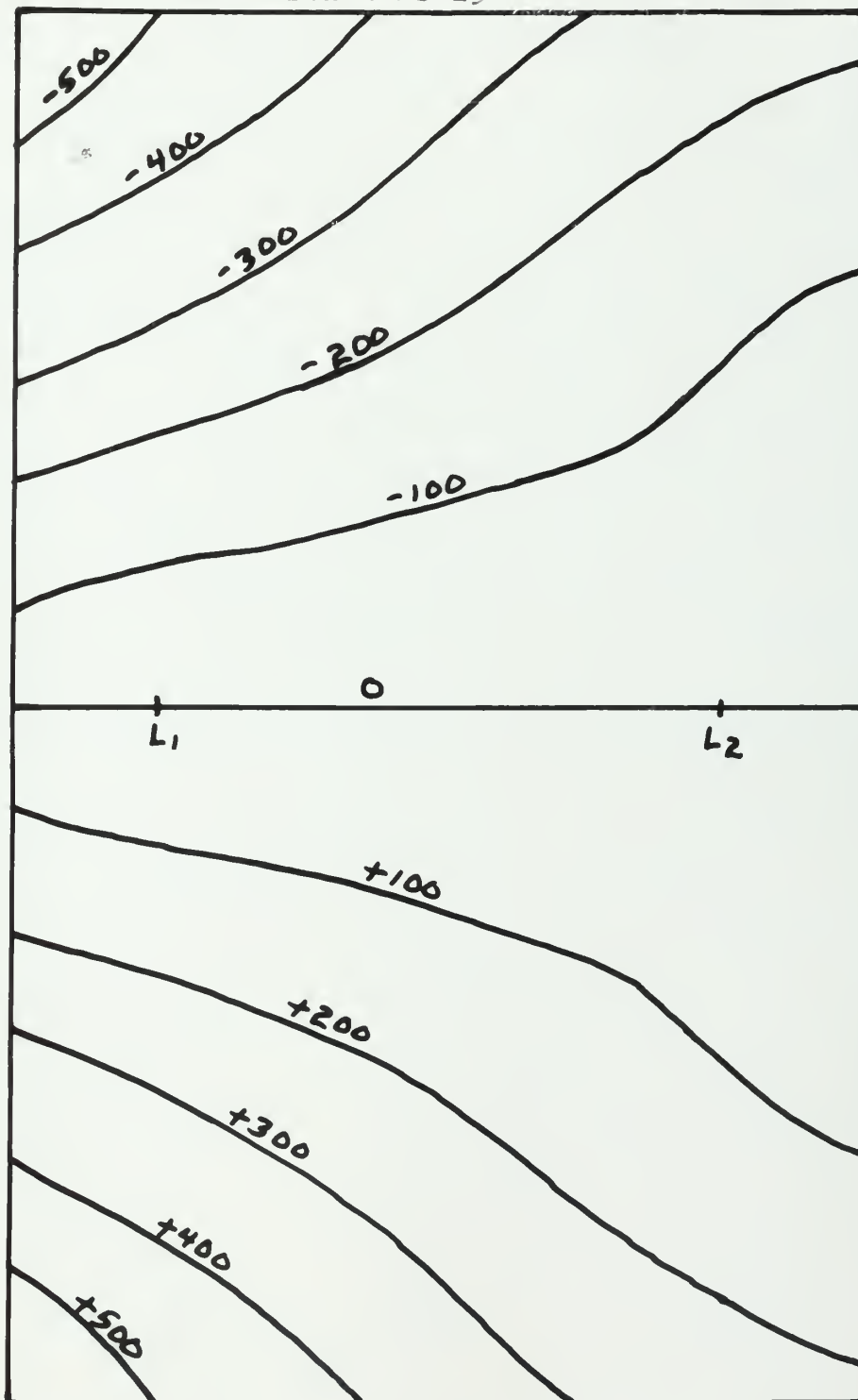
Average						
ϕ_1	ϕ_2	$\phi_1 - \phi_2$	ρy	dx''	$f dx''/x_{s_2}$	ϕ_0
(m)	(m)	(m)	(microns)	(m)	(m)	(m)
-0.54	-1.24	0.70	3.2	-0.035	0.05	-1.29
-0.54	-1.62	1.08	4.1	0.076	-0.15	-1.47
-0.58	-1.10	0.52	4.1	-0.106	0.14	-1.24
-0.58	-1.19	0.61	6.1	-0.002	0	-1.19
-0.58	-1.57	0.99	8.7	0.098	-0.21	-1.36
-0.58	-1.72	1.14	5.7	0.160	-0.43	-1.29
-0.80	-1.00	0.20	2.9	-0.021	0.03	-1.03
-0.80	-1.10	0.30	4.4	0.018	-0.03	-1.07
-0.80	-1.50	0.70	9.1	0.092	-0.23	-1.27
-0.55	-1.49	0.94	17.8	-0.198	0.26	-1.75
-0.55	-0.88	0.33	6.6	0.004	-0.01	-0.87
-0.55	-1.00	0.45	8.5	0.054	-0.13	-0.87
-0.02	-1.66	1.64	40.1	-0.289	0.39	-2.05
-0.02	-1.33	1.31	32.7	-0.051	0.08	-1.41
-0.02	-0.74	0.72	17.8	0.078	-0.17	-0.57
0.27	-1.15	1.42	42.1	0.133	-0.28	-0.87
-0.12	-0.46	0.34	10.1	0.032	-0.28	-0.18
0.27	-0.76	1.03	25.5	0.110	-0.79	0.03
-0.12	-0.66	0.54	13.5	-0.021	-0.58	-0.08
-0.32	-0.62	0.30	7.3	-0.053	-0.37	-0.25
-0.02	-1.15	1.13	21.4	0.137	-0.81	-0.31
0.27	-1.22	1.49	29.8	0.019	-1.46	0.24
-0.12	-1.14	1.02	19.3	-0.215	-1.30	0.16
-0.55	-1.58	1.03	13.4	0.135	-0.69	-0.89
-0.02	-1.50	1.48	21.8	0.090	-1.32	-0.18
0.27	-1.42	1.69	24.6	-0.174	-1.95	0.53
-0.80	-1.38	0.58	2.9	0.082	-0.36	-1.02
-0.55	-1.31	0.76	6.7	0.075	-0.60	-0.71
-0.02	-1.25	1.23	12.3	-0.004	-1.23	-0.02
0.27	-1.17	1.44	11.2	-0.293	-1.83	0.66
-0.55	-1.25	0.70	2.6	0.050	-0.61	-0.64
-0.02	-1.27	1.25	5.7	-0.062	-1.34	0.07

TABLE 1. SUMMARY OF DATA

SUMMARY						
STATION	DATE	TIME	WIND	WAVE	SEA	SWELL
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1/1/74	0800	10	1.5	1.5	1.5
2	1/1/74	0900	12	2.0	2.0	2.0
3	1/1/74	1000	15	2.5	2.5	2.5
4	1/1/74	1100	18	3.0	3.0	3.0
5	1/1/74	1200	20	3.5	3.5	3.5
6	1/1/74	1300	22	4.0	4.0	4.0
7	1/1/74	1400	25	4.5	4.5	4.5
8	1/1/74	1500	28	5.0	5.0	5.0
9	1/1/74	1600	30	5.5	5.5	5.5
10	1/1/74	1700	32	6.0	6.0	6.0
11	1/1/74	1800	35	6.5	6.5	6.5
12	1/1/74	1900	38	7.0	7.0	7.0
13	1/1/74	2000	40	7.5	7.5	7.5
14	1/1/74	2100	42	8.0	8.0	8.0
15	1/1/74	2200	45	8.5	8.5	8.5
16	1/1/74	2300	48	9.0	9.0	9.0
17	1/1/74	2400	50	9.5	9.5	9.5
18	1/1/74	2500	52	10.0	10.0	10.0
19	1/1/74	2600	55	10.5	10.5	10.5
20	1/1/74	2700	58	11.0	11.0	11.0
21	1/1/74	2800	60	11.5	11.5	11.5
22	1/1/74	2900	62	12.0	12.0	12.0
23	1/1/74	3000	65	12.5	12.5	12.5
24	1/1/74	3100	68	13.0	13.0	13.0
25	1/1/74	3200	70	13.5	13.5	13.5
26	1/1/74	3300	72	14.0	14.0	14.0
27	1/1/74	3400	75	14.5	14.5	14.5
28	1/1/74	3500	78	15.0	15.0	15.0
29	1/1/74	3600	80	15.5	15.5	15.5
30	1/1/74	3700	82	16.0	16.0	16.0
31	1/1/74	3800	85	16.5	16.5	16.5
32	1/1/74	3900	88	17.0	17.0	17.0
33	1/1/74	4000	90	17.5	17.5	17.5
34	1/1/74	4100	92	18.0	18.0	18.0
35	1/1/74	4200	95	18.5	18.5	18.5
36	1/1/74	4300	98	19.0	19.0	19.0
37	1/1/74	4400	100	19.5	19.5	19.5
38	1/1/74	4500	102	20.0	20.0	20.0
39	1/1/74	4600	105	20.5	20.5	20.5
40	1/1/74	4700	108	21.0	21.0	21.0
41	1/1/74	4800	110	21.5	21.5	21.5
42	1/1/74	4900	112	22.0	22.0	22.0
43	1/1/74	5000	115	22.5	22.5	22.5
44	1/1/74	5100	118	23.0	23.0	23.0
45	1/1/74	5200	120	23.5	23.5	23.5
46	1/1/74	5300	122	24.0	24.0	24.0
47	1/1/74	5400	125	24.5	24.5	24.5
48	1/1/74	5500	128	25.0	25.0	25.0
49	1/1/74	5600	130	25.5	25.5	25.5
50	1/1/74	5700	132	26.0	26.0	26.0
51	1/1/74	5800	135	26.5	26.5	26.5
52	1/1/74	5900	138	27.0	27.0	27.0
53	1/1/74	6000	140	27.5	27.5	27.5
54	1/1/74	6100	142	28.0	28.0	28.0
55	1/1/74	6200	145	28.5	28.5	28.5
56	1/1/74	6300	148	29.0	29.0	29.0
57	1/1/74	6400	150	29.5	29.5	29.5
58	1/1/74	6500	152	30.0	30.0	30.0
59	1/1/74	6600	155	30.5	30.5	30.5
60	1/1/74	6700	158	31.0	31.0	31.0
61	1/1/74	6800	160	31.5	31.5	31.5
62	1/1/74	6900	162	32.0	32.0	32.0
63	1/1/74	7000	165	32.5	32.5	32.5
64	1/1/74	7100	168	33.0	33.0	33.0
65	1/1/74	7200	170	33.5	33.5	33.5
66	1/1/74	7300	172	34.0	34.0	34.0
67	1/1/74	7400	175	34.5	34.5	34.5
68	1/1/74	7500	178	35.0	35.0	35.0
69	1/1/74	7600	180	35.5	35.5	35.5
70	1/1/74	7700	182	36.0	36.0	36.0
71	1/1/74	7800	185	36.5	36.5	36.5
72	1/1/74	7900	188	37.0	37.0	37.0
73	1/1/74	8000	190	37.5	37.5	37.5
74	1/1/74	8100	192	38.0	38.0	38.0
75	1/1/74	8200	195	38.5	38.5	38.5
76	1/1/74	8300	198	39.0	39.0	39.0
77	1/1/74	8400	200	39.5	39.5	39.5
78	1/1/74	8500	202	40.0	40.0	40.0
79	1/1/74	8600	205	40.5	40.5	40.5
80	1/1/74	8700	208	41.0	41.0	41.0
81	1/1/74	8800	210	41.5	41.5	41.5
82	1/1/74	8900	212	42.0	42.0	42.0
83	1/1/74	9000	215	42.5	42.5	42.5
84	1/1/74	9100	218	43.0	43.0	43.0
85	1/1/74	9200	220	43.5	43.5	43.5
86	1/1/74	9300	222	44.0	44.0	44.0
87	1/1/74	9400	225	44.5	44.5	44.5
88	1/1/74	9500	228	45.0	45.0	45.0
89	1/1/74	9600	230	45.5	45.5	45.5
90	1/1/74	9700	232	46.0	46.0	46.0
91	1/1/74	9800	235	46.5	46.5	46.5
92	1/1/74	9900	238	47.0	47.0	47.0
93	1/1/74	0000	240	47.5	47.5	47.5
94	1/1/74	0100	242	48.0	48.0	48.0
95	1/1/74	0200	245	48.5	48.5	48.5
96	1/1/74	0300	248	49.0	49.0	49.0
97	1/1/74	0400	250	49.5	49.5	49.5
98	1/1/74	0500	252	50.0	50.0	50.0
99	1/1/74	0600	255	50.5	50.5	50.5
100	1/1/74	0700	258	51.0	51.0	51.0

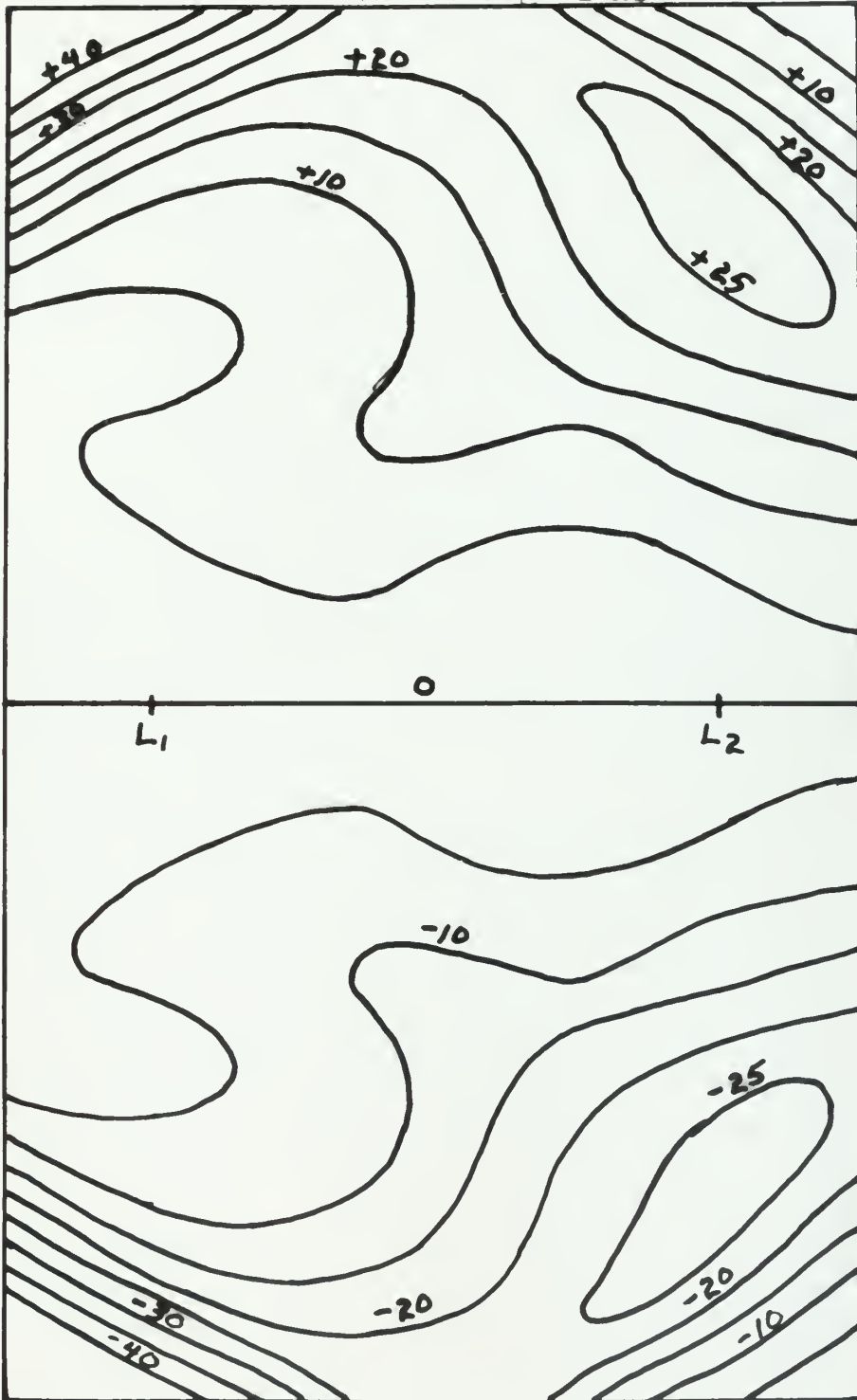
Figure 21

Y-parallax in microns
Model formed with lens 13



Y-Parallax in microns

Model formed with the average lens



Y-Parallax in microns
Model formed with lens 1

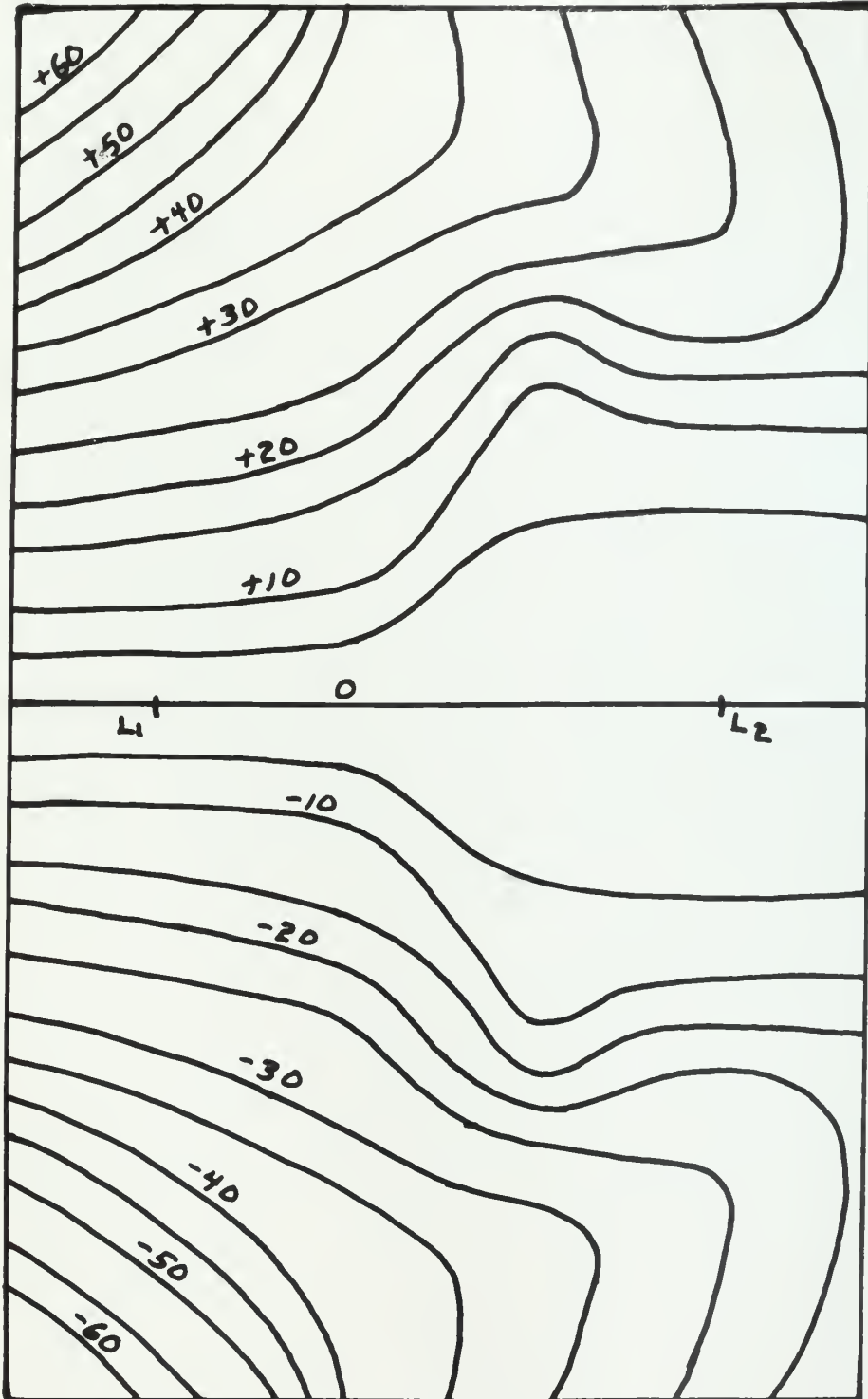
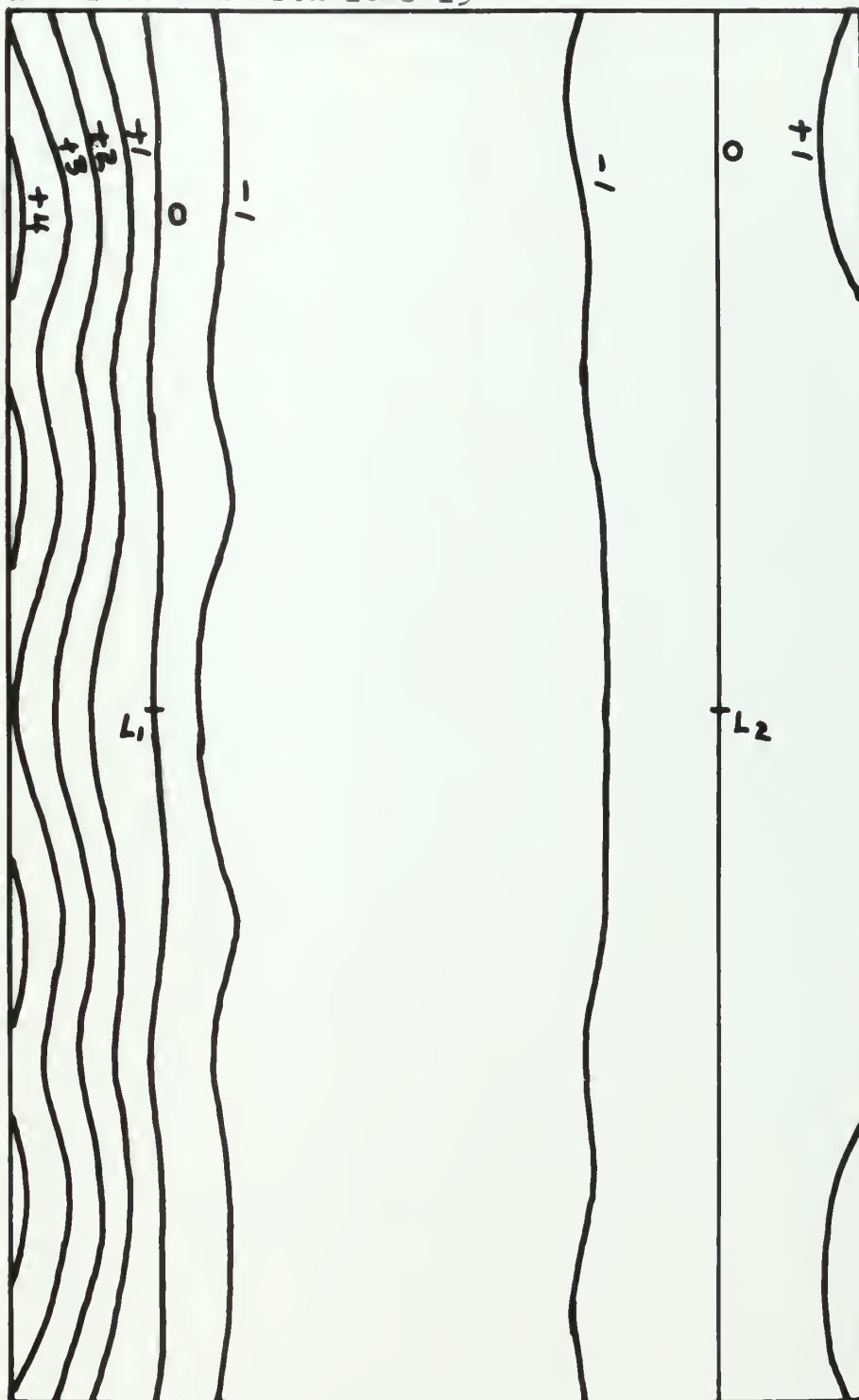
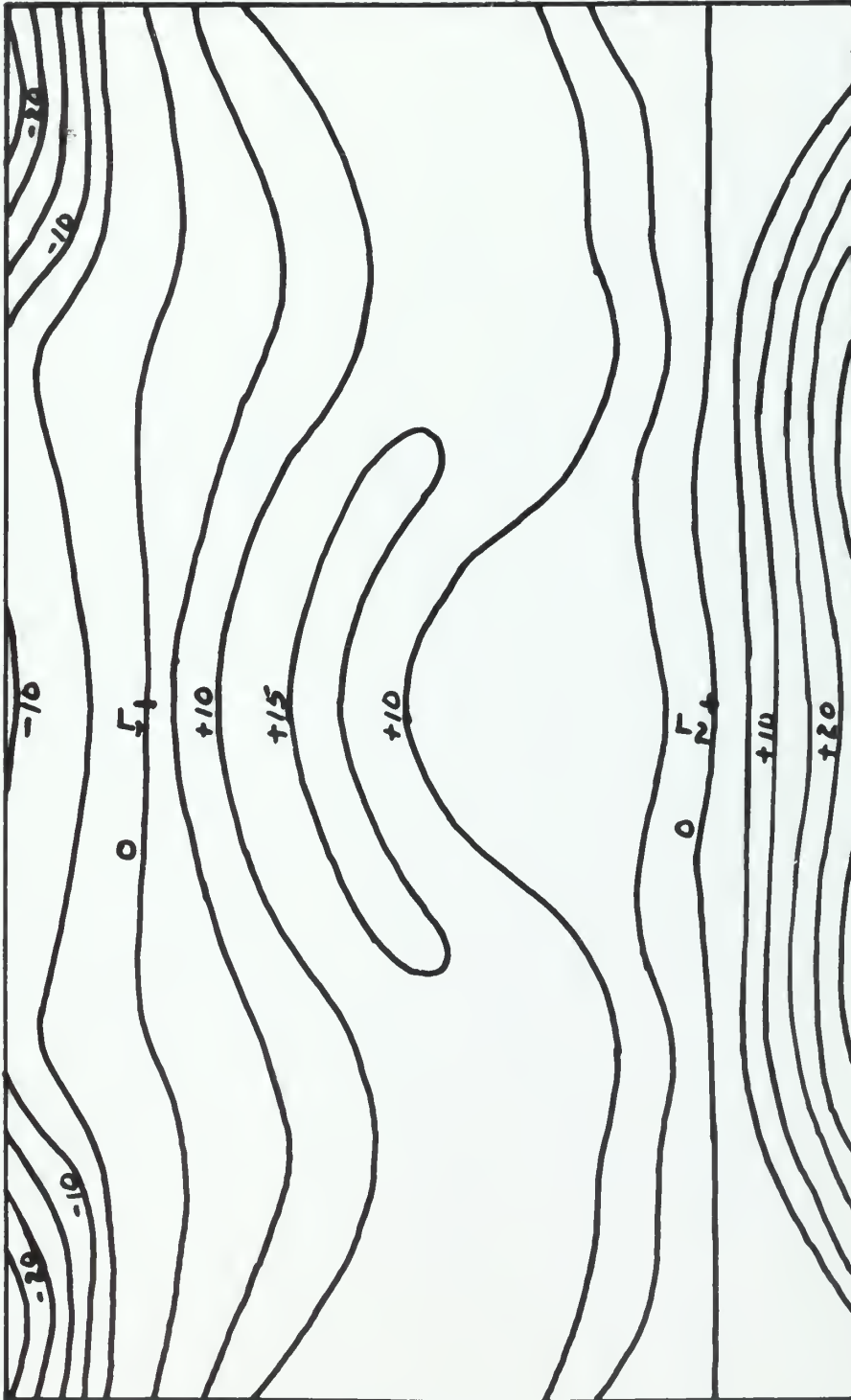


Figure 24

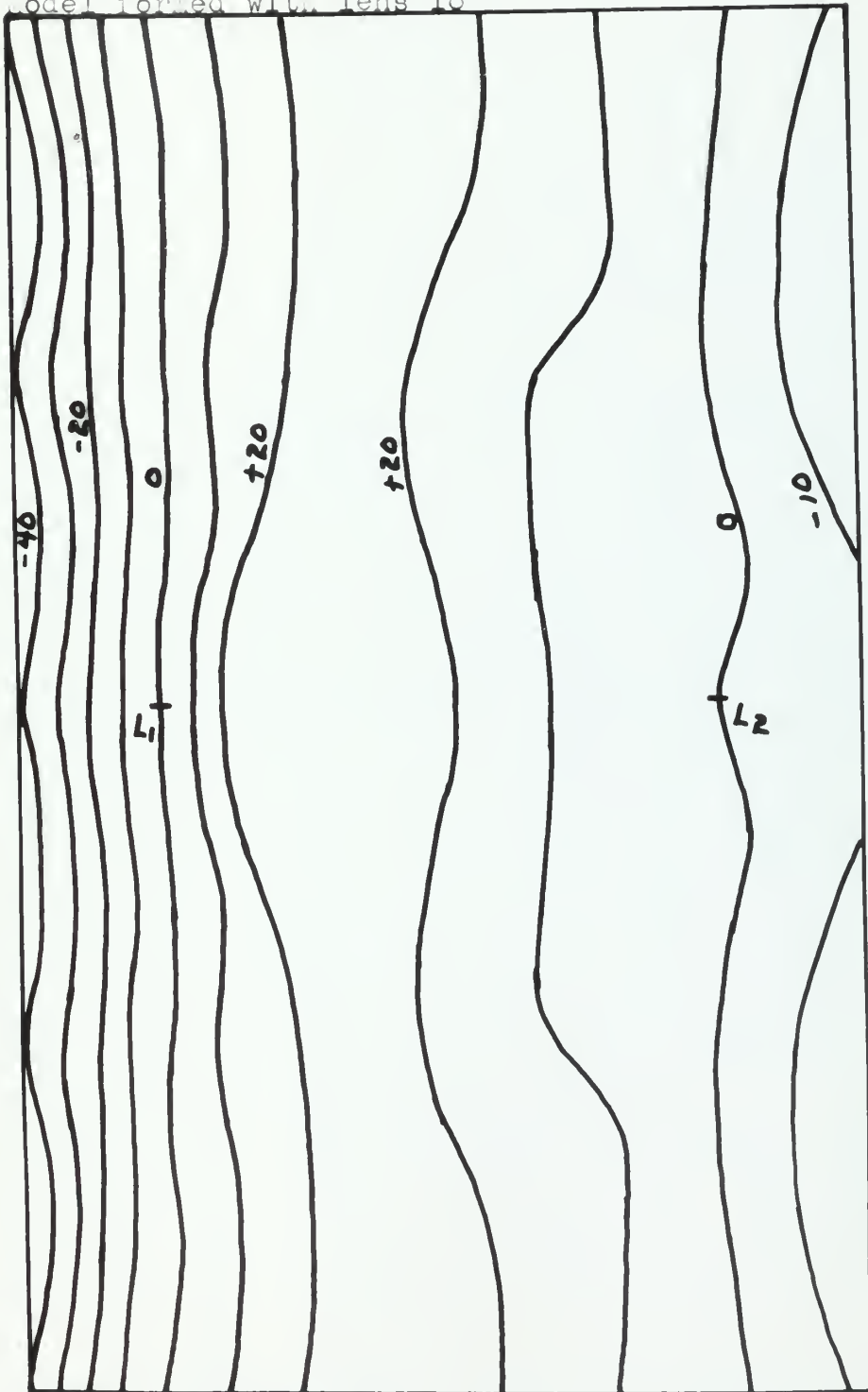
X-direction errors in meters
Model formed with lens 13



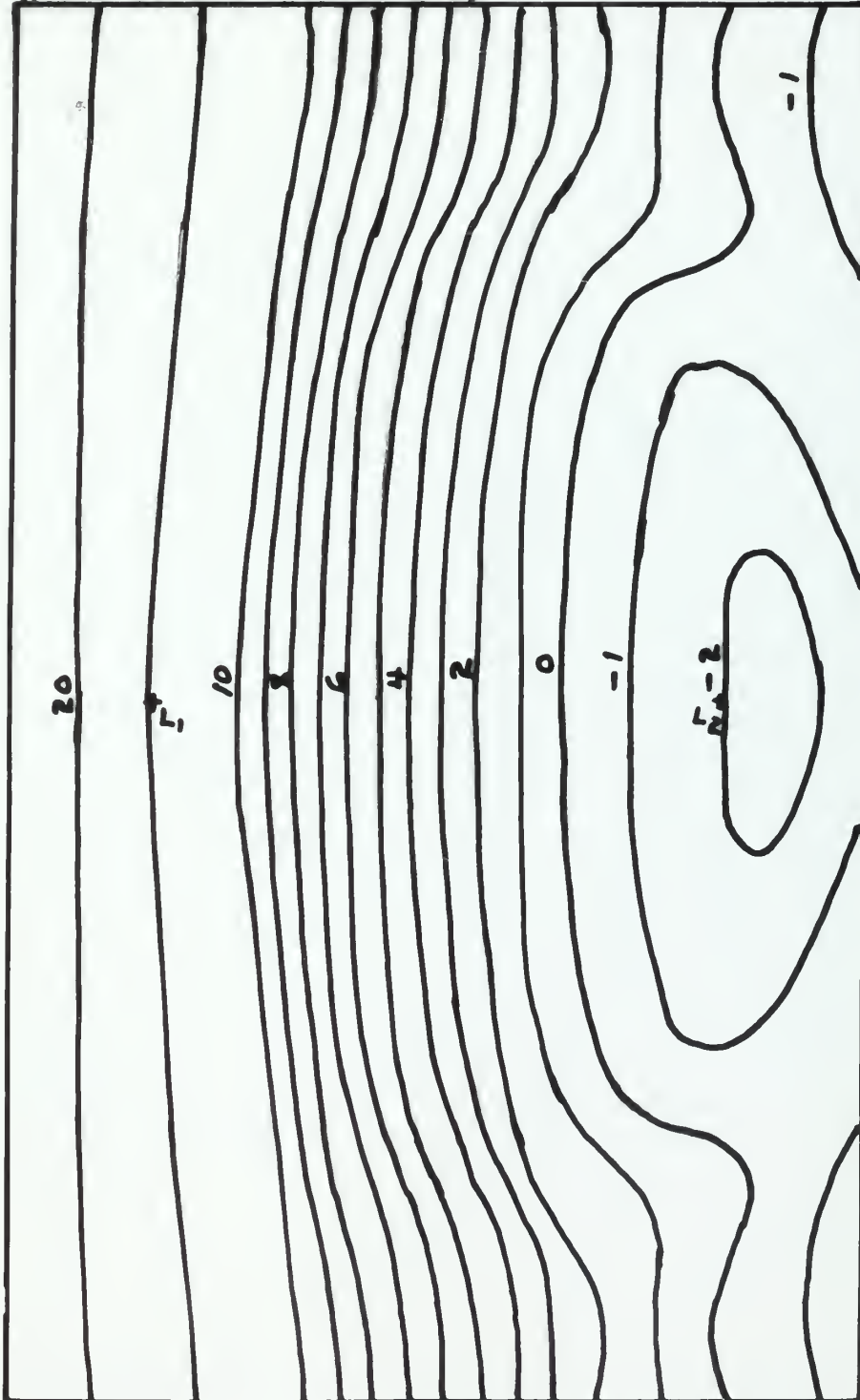
λ -direction errors in centimeters
Model formed with the average lens



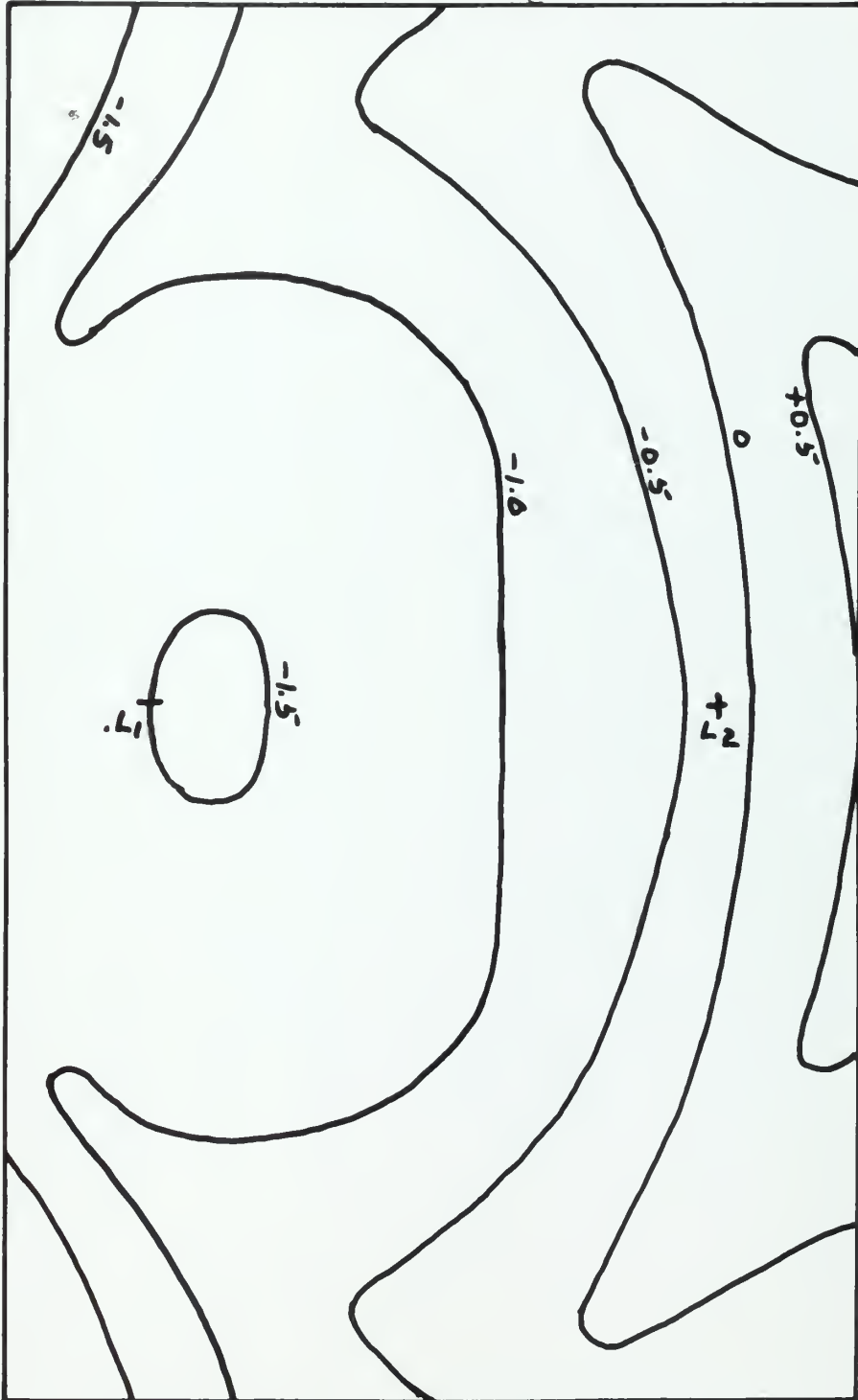
A-direction errors in centimeters
Model forced with lens 18



Elevation errors in meters
Model formed with lens 13



elevation errors in meters
Model formed with the average lens



Elevation errors in meters
Model Formed with lens 18

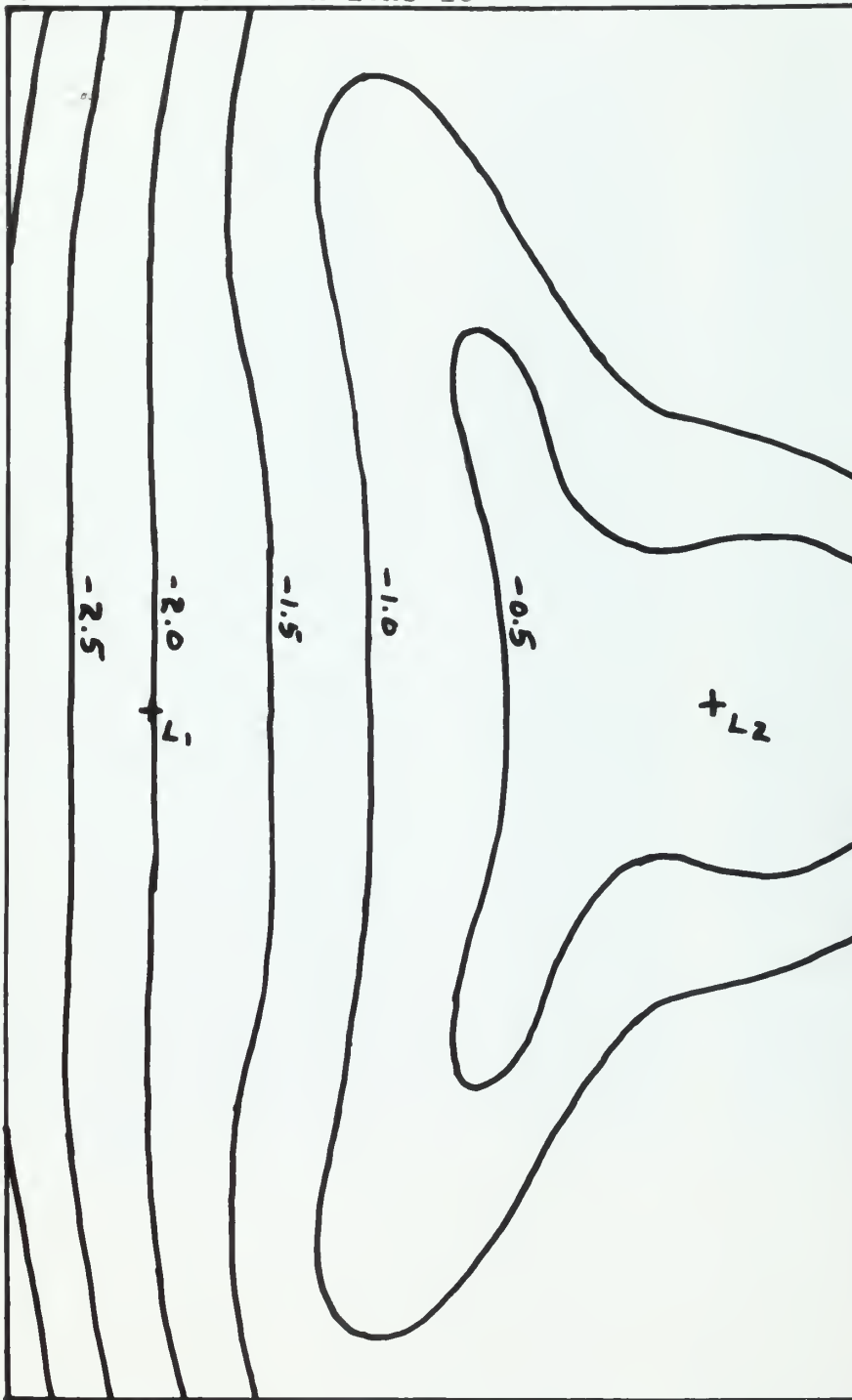


TABLE XXVII

	X(E)	Given in Feet	
		Y(N)	Z
Spro	1,593,463.81	604,404.94	684.8
Garner	1,593,451.33	603,023.15	686.2
Albert	1,594,756.93	603,076.95	685.3
Hoef	1,593,453.70	601,744.91	686.5
Weasel	1,593,375.11	600,236.17	694.5
Sarah	1,593,442.88	599,093.65	692.0
Young	1,594,738.14	599,159.21	692.3
School	1,593,438.27	597,797.52	693.0
Seigfred	1,593,421.23	595,098.23	692.4
Gentes	1,593,406.32	593,761.58	693.7
Dickmender	1,596,071.06	597,814.30	690.1
Fresse	1,597,404.30	597,760.06	690.1
Hastedt	1,598,651.10	593,773.10	694.5
John	1,598,740.74	595,063.89	692.3
Field	1,598,749.86	596,380.53	691.6
Fickle	1,598,754.96	597,752.22	690.6
Niekmeier	1,600,361.16	597,694.69	693.4
Alvah	1,601,378.97	597,752.70	691.8
Austin	1,598,690.78	598,893.28	689.2
Rich	1,598,810.24	600,368.86	687.1
Thompson	1,598,758.48	601,701.38	685.9
Richard	1,598,684.02	603,122.47	685.4
Florence	1,598,786.36	604,340.80	687.0
Blue	1,602,746.73	602,984.10	684.8
Meyers	1,604,049.62	604,317.81	683.9
H-116	1,604,103.93	603,038.92	684.9
Rowland	1,604,025.50	601,508.11	685.5
Fuller	1,604,018.30	600,357.58	686.7
Father	1,602,719.26	599,039.58	688.6
Haako	1,604,065.99	595,788.10	691.8
Winner	1,603,997.86	594,194.80	695.7
Hoskinson	1,609,391.79	600,332.56	686.9
Lange	1,593,421.79	596,401.23	693.4

2	SOUTH 1/2 CORNER (N7)	(S12)	
1. 100	10. 100, 100	10. 100, 100, 1	1000
2. 100	11. 100, 100	11. 100, 100, 1	1000
3. 100	12. 100, 100	12. 100, 100, 1	1000
4. 100	13. 100, 100	13. 100, 100, 1	1000
5. 100	14. 100, 100	14. 100, 100, 1	1000
6. 100	15. 100, 100	15. 100, 100, 1	1000
7. 100	16. 100, 100	16. 100, 100, 1	1000
8. 100	17. 100, 100	17. 100, 100, 1	1000
9. 100	18. 100, 100	18. 100, 100, 1	1000
10. 100	19. 100, 100	19. 100, 100, 1	1000
11. 100	20. 100, 100	20. 100, 100, 1	1000
12. 100	21. 100, 100	21. 100, 100, 1	1000
13. 100	22. 100, 100	22. 100, 100, 1	1000
14. 100	23. 100, 100	23. 100, 100, 1	1000
15. 100	24. 100, 100	24. 100, 100, 1	1000
16. 100	25. 100, 100	25. 100, 100, 1	1000
17. 100	26. 100, 100	26. 100, 100, 1	1000
18. 100	27. 100, 100	27. 100, 100, 1	1000
19. 100	28. 100, 100	28. 100, 100, 1	1000
20. 100	29. 100, 100	29. 100, 100, 1	1000
21. 100	30. 100, 100	30. 100, 100, 1	1000
22. 100	31. 100, 100	31. 100, 100, 1	1000
23. 100	32. 100, 100	32. 100, 100, 1	1000
24. 100	33. 100, 100	33. 100, 100, 1	1000
25. 100	34. 100, 100	34. 100, 100, 1	1000
26. 100	35. 100, 100	35. 100, 100, 1	1000
27. 100	36. 100, 100	36. 100, 100, 1	1000
28. 100	37. 100, 100	37. 100, 100, 1	1000
29. 100	38. 100, 100	38. 100, 100, 1	1000
30. 100	39. 100, 100	39. 100, 100, 1	1000
31. 100	40. 100, 100	40. 100, 100, 1	1000
32. 100	41. 100, 100	41. 100, 100, 1	1000
33. 100	42. 100, 100	42. 100, 100, 1	1000
34. 100	43. 100, 100	43. 100, 100, 1	1000
35. 100	44. 100, 100	44. 100, 100, 1	1000
36. 100	45. 100, 100	45. 100, 100, 1	1000
37. 100	46. 100, 100	46. 100, 100, 1	1000
38. 100	47. 100, 100	47. 100, 100, 1	1000
39. 100	48. 100, 100	48. 100, 100, 1	1000
40. 100	49. 100, 100	49. 100, 100, 1	1000
41. 100	50. 100, 100	50. 100, 100, 1	1000
42. 100	51. 100, 100	51. 100, 100, 1	1000
43. 100	52. 100, 100	52. 100, 100, 1	1000
44. 100	53. 100, 100	53. 100, 100, 1	1000
45. 100	54. 100, 100	54. 100, 100, 1	1000
46. 100	55. 100, 100	55. 100, 100, 1	1000
47. 100	56. 100, 100	56. 100, 100, 1	1000
48. 100	57. 100, 100	57. 100, 100, 1	1000
49. 100	58. 100, 100	58. 100, 100, 1	1000
50. 100	59. 100, 100	59. 100, 100, 1	1000
51. 100	60. 100, 100	60. 100, 100, 1	1000
52. 100	61. 100, 100	61. 100, 100, 1	1000
53. 100	62. 100, 100	62. 100, 100, 1	1000
54. 100	63. 100, 100	63. 100, 100, 1	1000
55. 100	64. 100, 100	64. 100, 100, 1	1000
56. 100	65. 100, 100	65. 100, 100, 1	1000
57. 100	66. 100, 100	66. 100, 100, 1	1000
58. 100	67. 100, 100	67. 100, 100, 1	1000
59. 100	68. 100, 100	68. 100, 100, 1	1000
60. 100	69. 100, 100	69. 100, 100, 1	1000
61. 100	70. 100, 100	70. 100, 100, 1	1000
62. 100	71. 100, 100	71. 100, 100, 1	1000
63. 100	72. 100, 100	72. 100, 100, 1	1000
64. 100	73. 100, 100	73. 100, 100, 1	1000
65. 100	74. 100, 100	74. 100, 100, 1	1000
66. 100	75. 100, 100	75. 100, 100, 1	1000
67. 100	76. 100, 100	76. 100, 100, 1	1000
68. 100	77. 100, 100	77. 100, 100, 1	1000
69. 100	78. 100, 100	78. 100, 100, 1	1000
70. 100	79. 100, 100	79. 100, 100, 1	1000
71. 100	80. 100, 100	80. 100, 100, 1	1000
72. 100	81. 100, 100	81. 100, 100, 1	1000
73. 100	82. 100, 100	82. 100, 100, 1	1000
74. 100	83. 100, 100	83. 100, 100, 1	1000
75. 100	84. 100, 100	84. 100, 100, 1	1000
76. 100	85. 100, 100	85. 100, 100, 1	1000
77. 100	86. 100, 100	86. 100, 100, 1	1000
78. 100	87. 100, 100	87. 100, 100, 1	1000
79. 100	88. 100, 100	88. 100, 100, 1	1000
80. 100	89. 100, 100	89. 100, 100, 1	1000
81. 100	90. 100, 100	90. 100, 100, 1	1000
82. 100	91. 100, 100	91. 100, 100, 1	1000
83. 100	92. 100, 100	92. 100, 100, 1	1000
84. 100	93. 100, 100	93. 100, 100, 1	1000
85. 100	94. 100, 100	94. 100, 100, 1	1000
86. 100	95. 100, 100	95. 100, 100, 1	1000
87. 100	96. 100, 100	96. 100, 100, 1	1000
88. 100	97. 100, 100	97. 100, 100, 1	1000
89. 100	98. 100, 100	98. 100, 100, 1	1000
90. 100	99. 100, 100	99. 100, 100, 1	1000
91. 100	100. 100, 100	100. 100, 100, 1	1000

TABLE XXVII—Continued

Observed			Observed at Ground Scale in Feet	
X(E) (mm)	Y(E) (mm)	Z (ft)	E	N
808.66	1,284.24	685.1	42,133.86	26,530.84
766.57	1,283.41	684.6	42,106.63	25,149.94
769.43	1,243.66	685.1	40,802.49	25,243.77
727.62	1,282.13	685.1	42,064.63	23,872.05
681.60	1,283.16	693.1	42,098.43	22,362.21
646.83	1,280.13	688.3	41,999.02	21,221.46
650.02	1,240.74	688.8	40,706.69	21,326.12
607.32	1,279.12	686.1	41,965.88	19,925.20
525.00	1,277.16	682.8	41,901.58	17,224.41
484.26	1,276.47	684.3	41,878.94	15,887.80
610.23	1,198.90	687.7	39,333.99	20,020.67
609.75	1,158.27	689.5	38,000.99	20,004.92
489.37	1,116.75	674.2	36,638.78	16,055.45
528.84	1,115.10	695.3	36,584.65	17,350.39
568.98	1,116.03	694.5	36,615.16	18,667.32
610.77	1,117.10	694.3	36,650.26	20,038.39
610.52	1,068.17	697.2	35,044.95	20,030.18
613.19	1,037.23	695.7	34,029.86	20,117.78
645.50	1,120.08	689.3	36,748.03	21,177.82
690.60	1,117.82	686.4	36,673.89	22,657.48
731.11	1,120.60	686.7	36,765.09	23,986.55
774.38	1,124.12	684.2	36,880.58	25,406.17
811.58	1,122.16	683.7	36,816.27	26,626.64
773.90	1,000.33	686.3	32,819.23	25,390.42
815.72	961.80	681.5	31,555.12	26,762.47
776.80	959.03	686.8	31,464.24	25,485.57
730.07	959.97	684.5	31,495.08	23,952.43
695.00	959.15	685.3	31,468.18	22,801.84
653.66	997.54	690.5	32,727.69	21,445.54
555.80	953.61	699.3	31,286.42	18,234.91
507.26	954.28	707.3	31,308.40	16,642.39
699.12	795.45	689.8	26,097.44	22,937.01
564.70	1,278.31	689.2	41,939.31	18,526.90

Frequency in GHz		Wavelength		
f	λ	λ (m)	λ (cm)	λ (in)
15,000,000	20.000,00	2.000	15.849,6	62.500
16,000,000	18.750,00	1.875	14.630,4	57.597
17,000,000	17.647,06	1.765	13.500,0	53.149
18,000,000	16.666,67	1.667	12.499,2	49.205
19,000,000	15.789,47	1.579	11.570,4	45.158
20,000,000	15.000,00	1.500	10.692,8	41.693
21,000,000	14.285,71	1.429	9.842,6	38.750
22,000,000	13.636,36	1.364	9.000,0	35.827
23,000,000	13.043,48	1.304	8.167,3	32.926
24,000,000	12.500,00	1.250	7.353,6	30.048
25,000,000	12.000,00	1.200	6.558,4	27.193
26,000,000	11.538,46	1.154	5.780,8	24.362
27,000,000	11.111,11	1.111	5.020,8	21.551
28,000,000	10.714,29	1.071	4.278,4	19.768
29,000,000	10.344,83	1.034	3.552,0	17.929
30,000,000	10.000,00	1.000	2.832,0	16.125
31,000,000	9.677,42	0.968	2.128,0	14.353
32,000,000	9.375,00	0.938	1.438,4	12.619
33,000,000	9.090,91	0.909	0.750,0	10.925
34,000,000	8.823,53	0.882	0.460,8	9.270
35,000,000	8.571,43	0.857	0.266,4	7.643
36,000,000	8.333,33	0.833	0.152,0	6.048
37,000,000	8.108,11	0.811	0.084,0	4.496
38,000,000	7.894,74	0.789	0.048,0	2.982
39,000,000	7.692,31	0.769	0.026,4	1.530
40,000,000	7.500,00	0.750	0.014,4	0.562
41,000,000	7.317,07	0.732	0.008,0	0.315
42,000,000	7.142,86	0.714	0.004,8	0.190
43,000,000	6.976,74	0.698	0.002,6	0.104
44,000,000	6.818,18	0.682	0.001,4	0.056
45,000,000	6.666,67	0.667	0.000,8	0.031
46,000,000	6.521,74	0.652	0.000,4	0.016
47,000,000	6.382,98	0.638	0.000,2	0.008
48,000,000	6.250,00	0.625	0.000,1	0.004
49,000,000	6.122,45	0.612	0.000,1	0.002
50,000,000	6.000,00	0.600	0.000,0	0.001

TABLE XXVII--Continued

Observed at Given Origin		Observed at Local Origin	
E	N	E	N
1,593,304.95	604,246.30	-5,385.83	5,353.02
1,593,332.18	602,865.40	-5,358.60	3,972.12
1,594,636.32	602,959.23	-4,054.46	4,065.95
1,593,374.18	601,587.51	-5,316.60	2,694.23
1,593,340.38	600,077.67	-5,350.40	1,184.39
1,593,439.79	598,936.92	-5,250.99	43.64
1,594,732.12	599,041.58	-3,958.66	148.30
1,593,472.93	597,640.66	-5,217.85	-1,252.62
1,593,537.23	594,939.87	-5,153.55	-3,953.41
1,593,559.87	593,603.26	-5,130.91	-5,290.02
1,596,104.82	597,736.13	-2,585.96	-1,157.15
1,597,437.82	597,720.38	-1,252.96	-1,172.90
1,598,800.03	593,770.91	109.25	-5,122.37
1,598,854.16	595,065.85	163.38	-3,827.43
1,598,823.65	596,382.78	132.87	-2,510.50
1,598,788.55	597,753.85	97.77	-1,139.43
1,600,393.86	597,745.64	1,703.08	-1,147.64
1,601,408.95	597,833.24	2,718.17	-1,060.04
1,598,690.78	598,893.28	0	0
1,598,764.92	600,372.94	74.14	1,479.66
1,598,673.72	601,702.01	- 17.06	2,808.73
1,598,558.23	603,121.63	- 132.55	4,228.35
1,598,620.54	604,342.10	- 70.24	5,448.82
1,602,619.58	603,105.88	3,928.80	4,212.60
1,603,883.69	604,477.93	5,192.91	5,584.65
1,603,974.57	603,201.03	5,283.79	4,397.75
1,603,943.73	601,667.89	5,252.95	2,774.61
1,603,970.63	600,517.30	5,279.85	1,624.02
1,602,711.12	599,161.00	4,020.34	267.72
1,604,152.39	595,950.37	5,461.61	-2,942.91
1,604,130.41	594,357.85	5,439.63	-4,535.43
1,609,341.37	600,652.47	10,650.59	1,759.19
1,593,499.50	596,242.36	-5,191.28	-2,650.92

[illegible]

TABLE XXVII--Continued

Corrected Local Coordinates		Corrected Observed Coordinates	
E	N	E	N
-5,222.98	5,511.13	1,593,467.80	604,404.41
-5,237.02	4,130.15	1,593,453.76	603,023.43
-3,930.77	4,184.95	1,594,760.01	603,078.23
-5,233.23	2,851.69	1,593,457.55	601,744.97
-5,312.14	1,343.67	1,593,378.64	600,236.95
-5,246.88	200.55	1,593,443.90	599,093.83
-3,952.11	266.53	1,594,738.67	599,159.81
-5,250.49	-1,096.00	1,593,440.29	597,797.28
-5,268.95	-3,797.27	1,593,421.83	595,096.01
-5,286.27	-5,133.84	1,593,404.51	593,759.44
-2,888.15	-1,079.24	1,595,802.63	597,814.04
-1,287.34	-1,134.83	1,597,403.44	597,752.45
- 43.90	-5,122.90	1,598,646.88	593,770.38
48.90	-3,830.27	1,598,739.68	595,063.01
57.77	-2,513.13	1,598,748.55	596,380.15
63.66	-1,141.74	1,598,754.44	597,751.54
1,667.87	-1,182.60	1,600,358.65	597,710.68
2,685.04	-1,140.71	1,601,375.82	597,752.57
0	0	1,598,690.78	598,893.28
118.32	1,476.65	1,598,809.10	600,369.93
66.89	2,807.74	1,598,757.67	601,701.02
- 6.11	4,230.05	1,598,684.67	603,123.33
92.65	5,448.01	1,598,783.43	604,341.29
4,052.60	4,092.93	1,602,743.38	602,986.21
5,357.04	5,426.46	1,604,047.82	604,319.74
5,409.71	4,147.53	1,604,100.49	603,040.81
5,333.07	2,616.13	1,604,023.85	601,509.41
5,325.56	1,465.35	1,604,016.34	600,358.63
4,018.19	147.42	1,602,708.91	599,040.70
5,370.73	-3,104.57	1,604,061.51	595,788.71
5,301.17	-4,695.58	1,603,991.95	594,197.70
10,697.47	1,439.93	1,609,388.25	600,333.21
-5,267.73	-2,494.35	1,593,423.05	596,398.93

BIBLIOGRAPHY

BIBLIOGRAPHY		BIBLIOGRAPHY	
A	E	E	K
10.100.100	05.100.100.1	01.100.1	05.100.1
11.100.100	06.100.100.1	02.100.1	06.100.1
12.100.100	07.100.100.1	03.100.1	07.100.1
13.100.100	08.100.100.1	04.100.1	08.100.1
14.100.100	09.100.100.1	05.100.1	09.100.1
15.100.100	10.100.100.1	06.100.1	10.100.1
16.100.100	11.100.100.1	07.100.1	11.100.1
17.100.100	12.100.100.1	08.100.1	12.100.1
18.100.100	13.100.100.1	09.100.1	13.100.1
19.100.100	14.100.100.1	10.100.1	14.100.1
20.100.100	15.100.100.1	11.100.1	15.100.1
21.100.100	16.100.100.1	12.100.1	16.100.1
22.100.100	17.100.100.1	13.100.1	17.100.1
23.100.100	18.100.100.1	14.100.1	18.100.1
24.100.100	19.100.100.1	15.100.1	19.100.1
25.100.100	20.100.100.1	16.100.1	20.100.1
26.100.100	21.100.100.1	17.100.1	21.100.1
27.100.100	22.100.100.1	18.100.1	22.100.1
28.100.100	23.100.100.1	19.100.1	23.100.1
29.100.100	24.100.100.1	20.100.1	24.100.1
30.100.100	25.100.100.1	21.100.1	25.100.1
31.100.100	26.100.100.1	22.100.1	26.100.1
32.100.100	27.100.100.1	23.100.1	27.100.1
33.100.100	28.100.100.1	24.100.1	28.100.1
34.100.100	29.100.100.1	25.100.1	29.100.1
35.100.100	30.100.100.1	26.100.1	30.100.1
36.100.100	31.100.100.1	27.100.1	31.100.1
37.100.100	32.100.100.1	28.100.1	32.100.1
38.100.100	33.100.100.1	29.100.1	33.100.1
39.100.100	34.100.100.1	30.100.1	34.100.1
40.100.100	35.100.100.1	31.100.1	35.100.1
41.100.100	36.100.100.1	32.100.1	36.100.1
42.100.100	37.100.100.1	33.100.1	37.100.1
43.100.100	38.100.100.1	34.100.1	38.100.1
44.100.100	39.100.100.1	35.100.1	39.100.1
45.100.100	40.100.100.1	36.100.1	40.100.1
46.100.100	41.100.100.1	37.100.1	41.100.1
47.100.100	42.100.100.1	38.100.1	42.100.1
48.100.100	43.100.100.1	39.100.1	43.100.1
49.100.100	44.100.100.1	40.100.1	44.100.1
50.100.100	45.100.100.1	41.100.1	45.100.1
51.100.100	46.100.100.1	42.100.1	46.100.1
52.100.100	47.100.100.1	43.100.1	47.100.1
53.100.100	48.100.100.1	44.100.1	48.100.1
54.100.100	49.100.100.1	45.100.1	49.100.1
55.100.100	50.100.100.1	46.100.1	50.100.1
56.100.100	51.100.100.1	47.100.1	51.100.1
57.100.100	52.100.100.1	48.100.1	52.100.1
58.100.100	53.100.100.1	49.100.1	53.100.1
59.100.100	54.100.100.1	50.100.1	54.100.1
60.100.100	55.100.100.1	51.100.1	55.100.1
61.100.100	56.100.100.1	52.100.1	56.100.1
62.100.100	57.100.100.1	53.100.1	57.100.1
63.100.100	58.100.100.1	54.100.1	58.100.1
64.100.100	59.100.100.1	55.100.1	59.100.1
65.100.100	60.100.100.1	56.100.1	60.100.1
66.100.100	61.100.100.1	57.100.1	61.100.1
67.100.100	62.100.100.1	58.100.1	62.100.1
68.100.100	63.100.100.1	59.100.1	63.100.1
69.100.100	64.100.100.1	60.100.1	64.100.1
70.100.100	65.100.100.1	61.100.1	65.100.1
71.100.100	66.100.100.1	62.100.1	66.100.1
72.100.100	67.100.100.1	63.100.1	67.100.1
73.100.100	68.100.100.1	64.100.1	68.100.1
74.100.100	69.100.100.1	65.100.1	69.100.1
75.100.100	70.100.100.1	66.100.1	70.100.1
76.100.100	71.100.100.1	67.100.1	71.100.1
77.100.100	72.100.100.1	68.100.1	72.100.1
78.100.100	73.100.100.1	69.100.1	73.100.1
79.100.100	74.100.100.1	70.100.1	74.100.1
80.100.100	75.100.100.1	71.100.1	75.100.1
81.100.100	76.100.100.1	72.100.1	76.100.1
82.100.100	77.100.100.1	73.100.1	77.100.1
83.100.100	78.100.100.1	74.100.1	78.100.1
84.100.100	79.100.100.1	75.100.1	79.100.1
85.100.100	80.100.100.1	76.100.1	80.100.1
86.100.100	81.100.100.1	77.100.1	81.100.1
87.100.100	82.100.100.1	78.100.1	82.100.1
88.100.100	83.100.100.1	79.100.1	83.100.1
89.100.100	84.100.100.1	80.100.1	84.100.1
90.100.100	85.100.100.1	81.100.1	85.100.1
91.100.100	86.100.100.1	82.100.1	86.100.1
92.100.100	87.100.100.1	83.100.1	87.100.1
93.100.100	88.100.100.1	84.100.1	88.100.1
94.100.100	89.100.100.1	85.100.1	89.100.1
95.100.100	90.100.100.1	86.100.1	90.100.1
96.100.100	91.100.100.1	87.100.1	91.100.1
97.100.100	92.100.100.1	88.100.1	92.100.1
98.100.100	93.100.100.1	89.100.1	93.100.1
99.100.100	94.100.100.1	90.100.1	94.100.1
100.100.100	95.100.100.1	91.100.1	95.100.1

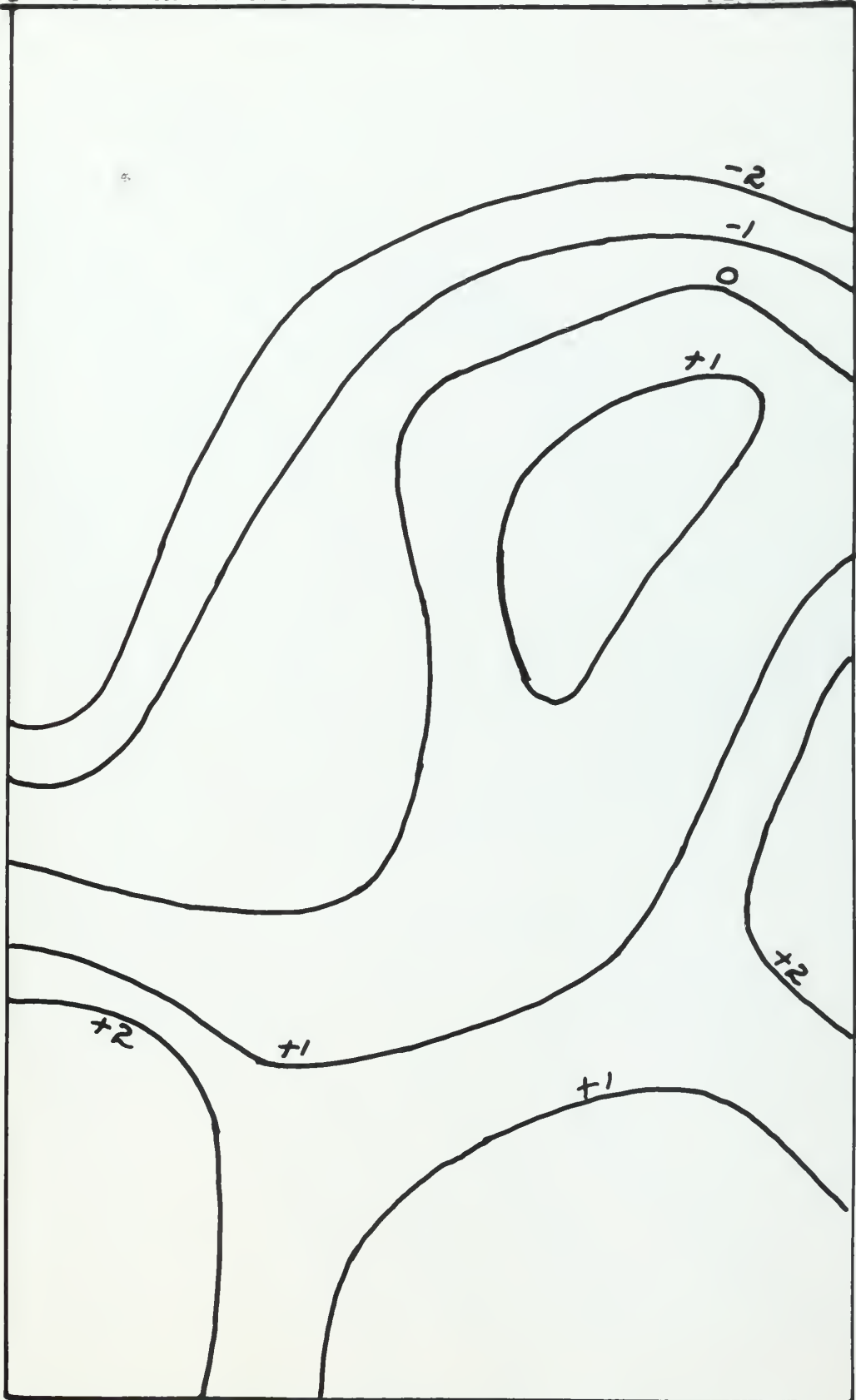
TABLE XXVII—Continued

Errors of Observations		
N(ft)	N(ft)	Z(ft)
+3.99	-0.53	0.3
+2.43	+0.28	-1.6
+3.08	+1.28	-0.2
+3.85	+0.06	-1.4
+3.53	-0.78	-1.4
+1.02	+0.18	-3.7
+0.53	+0.60	-3.5
+2.02	-0.24	-6.9
+0.60	-2.22	-9.6
-1.81	-2.14	-9.4
X	-0.26	-2.4
-0.86	-1.61	-0.6
-4.22	-2.72	X
-1.06	-0.88	3.0
-1.31	-0.38	2.9
-0.52	-0.68	0.7
-2.51	X	3.8
-3.15	-0.13	3.9
0	0	0.1
-1.14	+1.07	-0.7
-0.81	-0.36	0.8
+0.65	+0.86	-1.2
-2.93	+0.49	-3.3
-3.35	+1.89	1.5
-1.80	+1.93	-2.4
-3.44	+1.89	1.9
-1.65	+1.30	-1.0
-1.96	+1.05	-1.4
X	+1.12	1.9
-4.48	+0.61	-0.5
-5.91	+2.90	X
-3.54	+0.65	2.9
+1.26	-2.30	-4.2

X Apparent observation error.

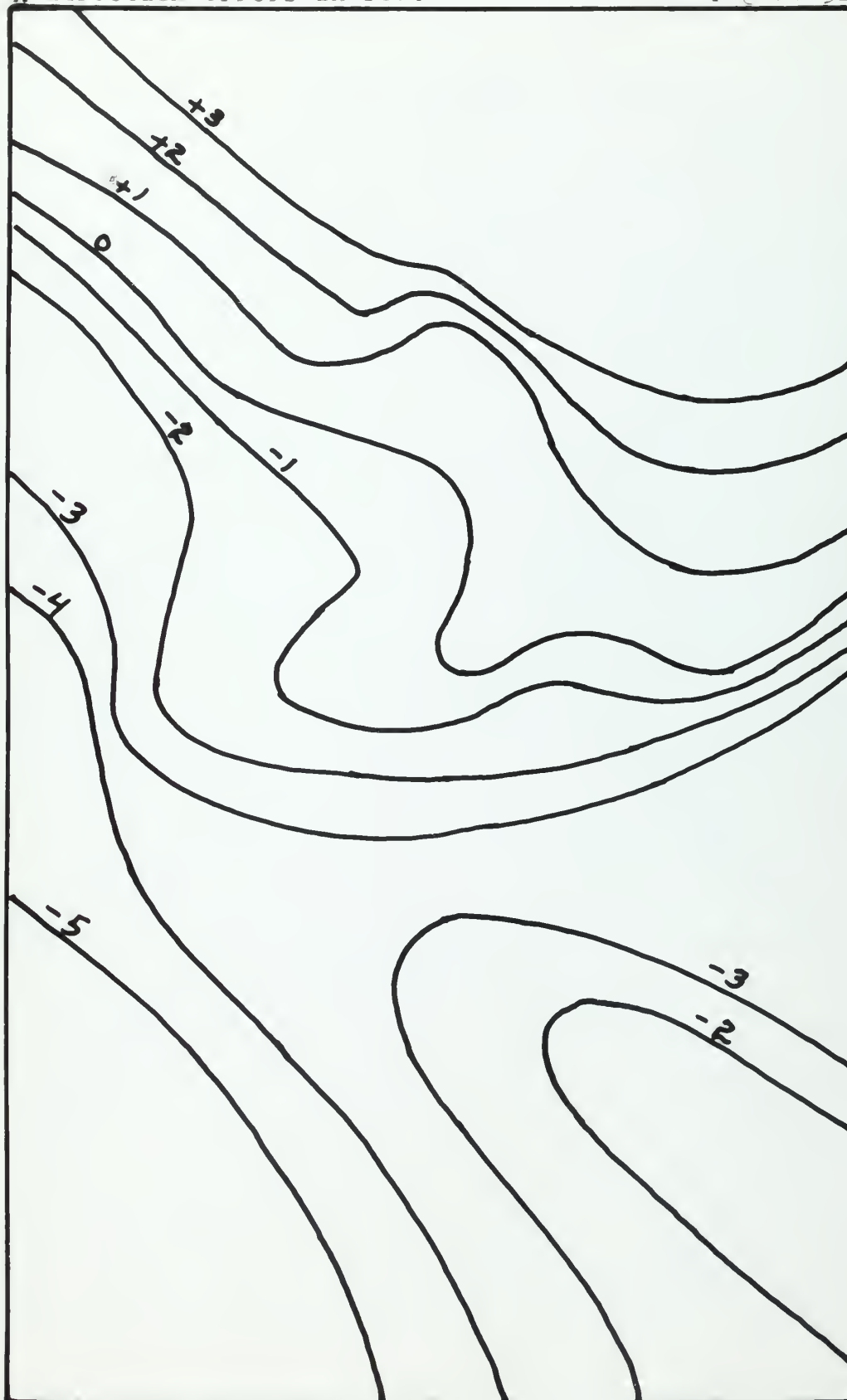
TABLE 1. — *Continued*

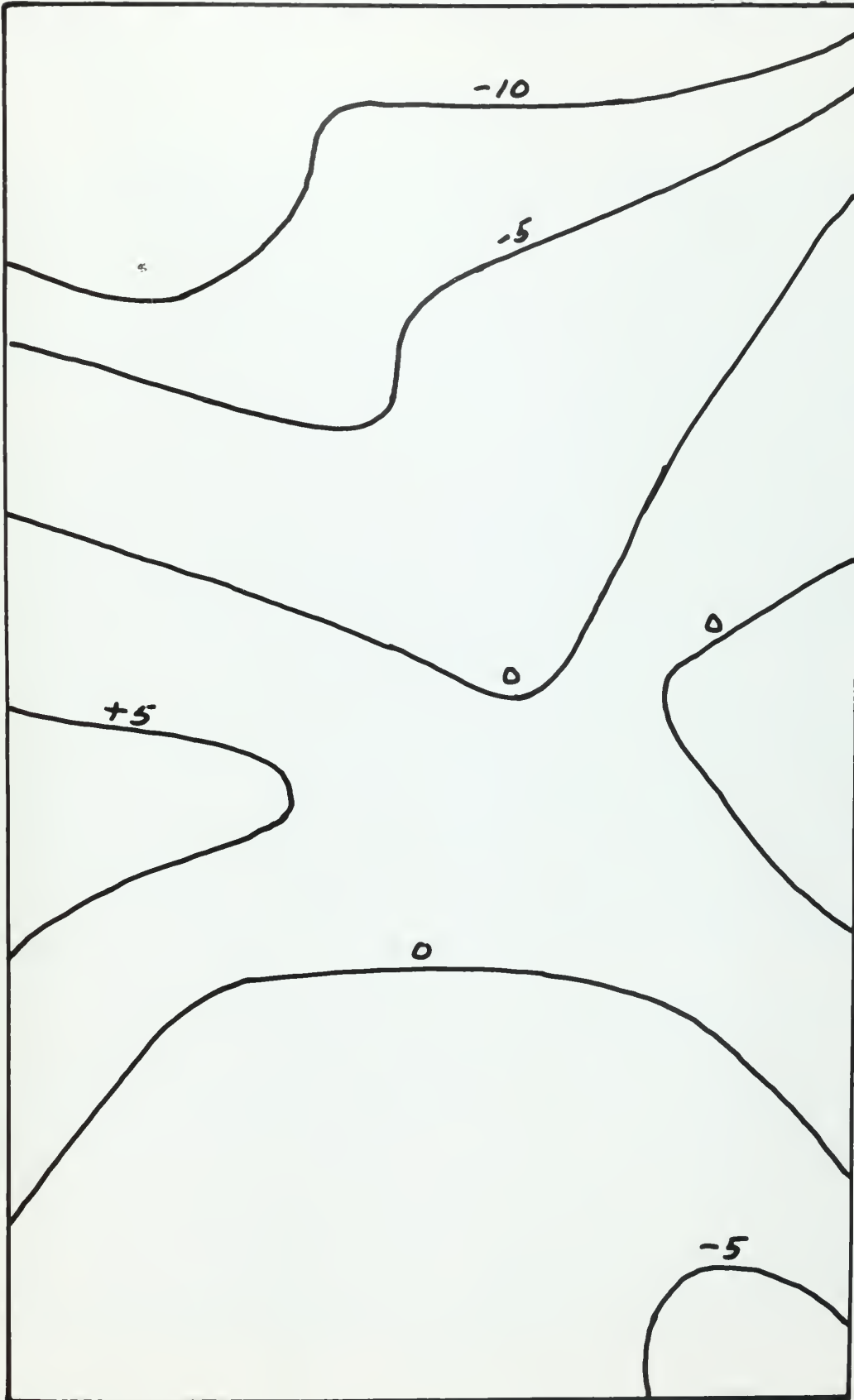
Number of specimens		
(1)	(2)	(3)
10	10.0	10.0
20	20.0	20.0
30	30.0	30.0
40	40.0	40.0
50	50.0	50.0
60	60.0	60.0
70	70.0	70.0
80	80.0	80.0
90	90.0	90.0
100	100.0	100.0
110	110.0	110.0
120	120.0	120.0
130	130.0	130.0
140	140.0	140.0
150	150.0	150.0
160	160.0	160.0
170	170.0	170.0
180	180.0	180.0
190	190.0	190.0
200	200.0	200.0
210	210.0	210.0
220	220.0	220.0
230	230.0	230.0
240	240.0	240.0
250	250.0	250.0
260	260.0	260.0
270	270.0	270.0
280	280.0	280.0
290	290.0	290.0
300	300.0	300.0
310	310.0	310.0
320	320.0	320.0
330	330.0	330.0
340	340.0	340.0
350	350.0	350.0
360	360.0	360.0
370	370.0	370.0
380	380.0	380.0
390	390.0	390.0
400	400.0	400.0
410	410.0	410.0
420	420.0	420.0
430	430.0	430.0
440	440.0	440.0
450	450.0	450.0
460	460.0	460.0
470	470.0	470.0
480	480.0	480.0
490	490.0	490.0
500	500.0	500.0



X-direction errors in feet

Figure 31





CONCLUSIONS

Assuming that the lens used in the photography measured is comparable to the average lens computed, a comparison of errors can be made, inasmuch as the elevation, 13,750', is approximately equal to the 4,000 m elevation assumed for other computations.

As is obvious from the difference in magnitude and pattern of error, the lack of a true spatial model prevents any meaningful comparison. With the exception of corner points, the elevation errors obtained were relatively close to being within the maximum computed for the average lens, however the range of errors was greater than computed for the average lens. The X-direction errors bore no resemblance to the computed graphs in either pattern or magnitude. The Y-direction errors cannot be computed, as previously discussed, due to the lack of ability to predict just where along the line between the two images, as separated by parallax, the point would be chosen. The magnitude of Y-direction errors, measured in the actual photography, is considerably less than the X-direction and elevation errors measured. The maximum predominant error in all coordinates was approximately 5 feet, which would put the accuracy at one part in 2,750 parts of elevation above the terrain. This accuracy would only be acceptable for most mapping requirements if flown at very low altitude above the terrain and controlled by

Introduction	1
Chapter I. The General Principles of the Theory of the Earth	15
Chapter II. The Physical Properties of the Earth	35
Chapter III. The Chemical Composition of the Earth	55
Chapter IV. The Geographical Distribution of the Earth	75
Chapter V. The Geological History of the Earth	95
Chapter VI. The Biological History of the Earth	115
Chapter VII. The Anthropological History of the Earth	135
Chapter VIII. The Social History of the Earth	155
Chapter IX. The Economic History of the Earth	175
Chapter X. The Political History of the Earth	195
Chapter XI. The Cultural History of the Earth	215
Chapter XII. The Religious History of the Earth	235
Chapter XIII. The Artistic History of the Earth	255
Chapter XIV. The Scientific History of the Earth	275
Chapter XV. The Philosophical History of the Earth	295
Chapter XVI. The Literary History of the Earth	315
Chapter XVII. The Musical History of the Earth	335
Chapter XVIII. The Dramatic History of the Earth	355
Chapter XIX. The Historical Fiction of the Earth	375
Chapter XX. The Historical Poetry of the Earth	395
Chapter XXI. The Historical Drama of the Earth	415
Chapter XXII. The Historical Novel of the Earth	435
Chapter XXIII. The Historical Romance of the Earth	455
Chapter XXIV. The Historical Legend of the Earth	475
Chapter XXV. The Historical Myth of the Earth	495
Chapter XXVI. The Historical Fable of the Earth	515
Chapter XXVII. The Historical Parable of the Earth	535
Chapter XXVIII. The Historical Allegory of the Earth	555
Chapter XXIX. The Historical Symbol of the Earth	575
Chapter XXX. The Historical Emblem of the Earth	595
Chapter XXXI. The Historical Motto of the Earth	615
Chapter XXXII. The Historical Slogan of the Earth	635
Chapter XXXIII. The Historical Cry of the Earth	655
Chapter XXXIV. The Historical Shout of the Earth	675
Chapter XXXV. The Historical Cheer of the Earth	695
Chapter XXXVI. The Historical Song of the Earth	715
Chapter XXXVII. The Historical Anthem of the Earth	735
Chapter XXXVIII. The Historical Hymn of the Earth	755
Chapter XXXIX. The Historical Psalm of the Earth	775
Chapter XL. The Historical Canticle of the Earth	795
Chapter XLI. The Historical Ode of the Earth	815
Chapter XLII. The Historical Elegy of the Earth	835
Chapter XLIII. The Historical Epitaph of the Earth	855
Chapter XLIV. The Historical Epitome of the Earth	875
Chapter XLV. The Historical Synopsis of the Earth	895
Chapter XLVI. The Historical Summary of the Earth	915
Chapter XLVII. The Historical Conclusion of the Earth	935
Chapter XLVIII. The Historical Epilogue of the Earth	955
Chapter XLIX. The Historical Postscript of the Earth	975
Chapter L. The Historical Appendix of the Earth	995

sufficient geodetic control or by high altitude normal angle photography.

Without the ability to obtain a true spatial model in the stereo plotter, the relatively high accuracy as computed for the X values of the average lens will not be achieved. Any tendency to warp the model to eliminate the parallax caused by lens distortion will tend to decrease the X coordinate accuracy. The elevation accuracy is also adversely affected by this warping but not to the same extent. The plus to minus range of errors is increased considerably but absolute errors are not increased too greatly. The Y -direction errors which would be obtained with a true spatial model would probably not be too great but cannot be predicted due to the range of possibilities of Y -positions due to parallax. The maximum of 15 microns parallax computed for the average lens would create a maximum Y -direction error of approximately one part in 10,000 of elevation above terrain. Thus to map with the above photographs taken at 13,000 feet above the terrain, the maximum mapping scale which could be used with mapping accuracy of 0.2 mm would be 1:6,000.

Thus metrogon photography is suitable for low altitude mapping with the altitude determined by the mapping accuracy required, but is not suitable for any control extension work. The only case in which metrogon photography would be suitable would be in case the distortion curve of the lens used was sufficiently close to the metrogon correction plates to be used to bring uncompensated errors throughout the model area to less than 10 microns.

the following points are noted by the various authors:

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